

JONES (Jos.)

OUTLINE OF OBSERVATIONS

ON

HOSPITAL GANGRENE

As it manifested itself in the Confederate Armies,

DURING THE AMERICAN CIVIL WAR, 1861-1865.

BY

JOSEPH JONES, M. D.,

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Louisiana.

NEW ORLEANS.

Printed at the "Bronze Pen" Book and Job Office, No. 112 Gravier Street

1869.



Prof. Samuel Jackson. M.D.
With kind regards 2

OUTLINE OF OBSERVATIONS

Joseph Jones. M.D.

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ON

This present "outline" was prepared in accordance with the

HOSPITAL GANGRENE

delivery was accompanied with the following explanatory

C. S. of Jackson, Augusta, GA, August, 1864

As it manifested itself in the Confederate Armies,

This is in accordance with the request of the Surgeon General, that the general results of my investigations into hospital gangrene, should be presented to the Medical Department, as soon as practicable after my return from Europe. I have the honor to submit the following brief outline of my subject. In the first and full report, the actual results have been arranged, and as yet unpublished.

DURING THE AMERICAN CIVIL WAR, 1861-1865.

The general hospitals attached to the Army of Tennessee, at the present time afford a wide and important field for the full investigation of hospital gangrene and pyemia, and I have accordingly immediately upon the extended and arduous labors performed at Savannah, and in the field and general hospital of the Western Department.

The Surgeon General will excuse the imperfect manner in which these results are now presented, as it was impossible to do justice in the subject in the brief space of time, which has been occupied with the numerous preparations necessary to the publication of investigations ordered by the Surgeon General; and especially the present state of my health, after my extended labors have greatly increased my duties in numerous inspections, and to the preparation of this report.

JOSEPH JONES, M. D.,

JOSEPH JONES, Surgeon, U. S. A.

I.—Outline of the Symptoms and Changes of the Solids and Fluids
Characteristics of Hospital Gangrene as it has Manifested itself

Professor of Chemistry in the Medical Department of the University of
Louisiana,

In many cases the appearance of gangrene in the wounds was preceded by fever, which was sometimes ushered in by a chill. This fever was accompanied with loss of appetite, depression of spirits, and sometimes with delirium, and such an excited irritative action of the bowels, and such an inflammatory action of the urinary apparatus, as denoted a depression of the vital forces.

NEW ORLEANS.

1869.

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OBSERVATIONS ON HOSPITAL GANGRENE.

THE present "outline" was prepared in accordance with the order of the Surgeon General, assigning the author to special duty in the investigation of camp diseases, and in its official deliverance was accompanied with the following explanatory note.

C. S. OF AMERICA, AUGUSTA, GA., August, 1864.

Surgeon General S. P. MOORE. C. S. A.

Surgeon Generals's Office, War Department Richmond, Va.

Sir: In accordance with the request of the Surgeon General "that the general results of my investigations upon hospital gangrene, should be forwarded to the Medical Department, as soon as practicable after my return from Virginia," I have the honor to submit the following brief outline of my labors.

In the final and full report, the general results here announced, will be supported and illustrated by cases, experiments, and chemical and microscopical investigations.

The general hospitals attached to the Army of Tennessee, at the present time afford a wide and important field for the full investigation of hospital gangrene and pyæmia, and I design entering immediately upon the extended pathological labors projected at Andersonville, and in the field and general hospitals of the Western Department.

The Surgeon General will please excuse the imperfect manner in which these results are now presented, as it was impossible to do justice to the subject in the brief space of time, which has been occupied with the numerous preparations necessary to the pathological investigations ordered by the Surgeon General; and especially in the present state of my health, after my energies have been greatly taxed for twelve months in numerous inspections, and in the preparation of an extended report on camp fevers.

Very respectfully your obedient servant,

JOSEPH JONES, Surgeon, P. A. C. S.

I.—*Outline of the Symptoms and Changes of the Solids and Fluids Characteristic of Hospital Gangrene as it has Manifested itself in the Confederate Armies. Constitutional Disturbances amongst the earlier symptoms of Hospital Gangrene; Local and Constitutional Origin of the Disease.*

In many cases the appearance of gangrene in the wounds was preceded by fever, which was sometimes ushered in by a chill. This fever was most commonly attended with loss of appetite, depression of spirits, constipation of the bowels, and such an enfeebled irritative action of the circulatory apparatus, as denoted a depression of the vital, nervous and muscular forces.

It has been difficult to determine whether the fever was the

resultant, or the necessary accompaniment of the early changes in the wound. It is, however, a point of interest in its bearing upon the determination of the nature of the disease, as well as upon the treatment, that the constitutional symptoms in many cases do precede such local changes as are sufficient to attract the attention of the patient and physician.

The Confederate troops have been so often exposed to malarious influences, that it is impossible to determine in most cases the cause and nature of the chill which sometimes precedes the fever. Without doubt, it was in some cases at least, of malarious origin. When the system has been brought under the influence of malaria, any depressing cause, as a gun-shot wound, especially if unfavorable changes are set up in the injured parts, may induce true chill and fever.

In the general hospitals attached to the Army of Northern Virginia, to the Department of South Carolina, Georgia and Florida, and to the Army of Tennessee, I have seen a number of cases of extensive hospital gangrene, in gun-shot wounds, and of those resulting from amputation and various operations, in which the disease was said to have appeared as a local affection, without any constitutional symptoms. Loss of appetite and febrile excitement was said to have been entirely absent, or else to have appeared only after the local disease had progressed to a considerable extent. These cases certainly manifested constitutional disturbances of the gravest character, when they passed under my examination, and in no case was I able to discern any accurate or critical record of the condition of the patients, and especially of the circulation, respiration, and temperature, and of the alimentary canal and nervous system, in the earliest stages of the disease. Such testimony to the local origin of hospital gangrene, should therefore be regarded only so far as to excite careful observations and investigations, upon the first recognizable symptoms. The question of the local or constitutional origin of hospital gangrene, can be settled definitely only by extended and minutely recorded observations upon the whole progress of the disease, from the first deviation from the condition of health. It is important to consider this question well, because the best writers on this subject differ in their views; and because it is intimately connected with every theory of the origin and nature of the disease, and with the great practical question, whether

hospital gangrene, is to be treated locally or constitutionally, or by both means combined.

In attempting to settle this question by an appeal to authority, the great difficulty is the want of accurate and minute observation of the earliest symptoms preceding the actual appearance of the gangrene. Thus, as far as our knowledge extends, no writer up to the present time has given any critical observations upon the changes of the temperature, urine and blood, at any period of the disease; and by the majority of writers, even the changes of the pulse and tongue are noticed only after the establishment of the gangrene. The simple announcement that the disease commenced as a *local affection and manifested no constitutional symptoms, until a certain period*, should not be taken as a final decision. Such general statements should be sustained by critical observations upon the most obvious phenomena of the animal system.

In its mode of origin, hospital gangrene may be viewed in four ways:

1st.—*As a local disease, communicable only by contact with animal matter in a certain state of change or decomposition.*

Whatever constitutional disturbances arise, they are always consequent to, and upon, the changes in the wound itself, and arise chiefly from a propagation of the derangement by nervous sympathy. If this proposition be true, amputation would be one of the most certain methods of removing the disease.

2d.—*As a constitutional disease.*

The constitutional disturbance manifesting itself in gangrenous inflammation, in any wounded surface, may be produced either by previous exposure and bad diet; or by the constant inhalation of an atmosphere deprived of its active oxygen, and electrical fluid, and loaded with carbonic acid gas and sulphuretted hydrogen and other deleterious gases and animal matters. According to this view, when the constitution is deranged, the blood altered, and the forces depressed, by such agencies, the disease may appear in any wounded surface, apart from any direct application of poisonous animal matter.

3d.—*As both local and constitutional in its origin.*

Animal matter in a certain state of decomposition is capable of acting upon a wounded surface, and of developing gangrenous

inflammation; or the system may be so depressed by the action of gases and foul air inhaled, and by the previous exposure and bad diet, that this form of inflammation may result from the depression of the forces, the derangement of nutrition, and the consequent degeneration of the wounded part.

If the disease arises locally, the absorption of the gangrenous matter commences as soon as it is applied to any wounded surface, and goes on continuously as long as any gangrene is present; and the decomposing matters entering the blood, derange its composition and the nutrition of the body and depress the forces. In this way the constitutional derangements may be manifested before the local changes are evident to the senses, without at all standing in the relation of cause and effect. The admission of its local and constitutional characters, at the same time, is not at all contradicted by the fact, that we may have in the same patient one gangrenous wound and another entirely free from the disease. Neither does it follow, that because the absorbed matters disturb the nutrition and composition of the blood, and derange to a certain extent the forces, therefore amputation will not arrest the disease. Whether or not the severing of the gangrenous mass from the body will arrest the disease, will depend not upon the mere fact of the absorption of the gangrenous matter, but upon the extent to which it has deranged the nutrition and depressed the forces. Thus the poison of the rattlesnake produces death of the immediate parts into which it is injected, and at the same time that portion which is absorbed, alters the blood, acts upon the heart, deranges the nutrition, disturbs the circulation and respiration, and depresses the venous and muscular systems. If the limb poisoned and rendered gangrenous by the poison of the rattlesnake, be amputated in the sound parts, it does not follow, that because the constitution has been affected by the poison absorbed, that therefore the stump must also become gangrenous. Neither does it follow that because the gangrene was not reproduced in the stump, therefore the poison of the rattlesnake did not act constitutionally.

In the case of amputation for a gangrenous wound, the re-appearance of gangrene in the wound, will depend on the amount of the matter absorbed from the local source, and the extent to which it has deranged the system.

4th.—*The disease may arise from the action of a specific poison,*

which acts in a manner similar to that of small pox, measles or scarlet fever.

After the introduction of the poison either through the wounded surfaces, or through the skin and lungs, certain constitutional changes are excited which precede the manifestation of the local symptoms, and are connected intimately with, if not in the relations of cause and effect with the local manifestations. In other words, the specific cause of hospital gangrene, may induce such changes in the constitution of the blood, and so modify the nutrition of the body and so depress the forces, that however the poison may have been received by direct contact to the wound, or through the atmosphere, all local inflammation may manifest its specific gangrenous action.

The third proposition expresses most nearly our views; for it is capable of demonstration by cases and instances which I have recorded and observed:

First—That hospital gangrene may arise in those exposed to the exhalations from gangrenous wounds, without any abrasion of the surface.

The poison inducing hospital gangrene, is capable of entering the system through the pulmonary and cutaneous systems, and of exciting gangrene in parts which were, perhaps, in a state of defective nutrition, degeneration or inflammation or depressed in vitality; but which as far as known, were not exposed in any manner to the direct action of the poisonous matter, and over which the integuments were intact, until they were involved by the gangrene from within.

Second—That hospital gangrene can be communicated through the atmosphere to wounded surfaces, without any direct application of the matter.

Third—That in some cases, after the wounds had been subjected to the action of the cause of hospital gangrene, a certain period of time elapses before the disease appears.

Fourth—That in some cases poisonous matters are so rapidly absorbed from the infected atmosphere of the crowded wards, and the diseased action is propagated with such rapidity from the local injury to the central organs in constitutions broken down by bad diet, exposure, and by the influence of the foul emanations from the wounded

and sick crowded into badly ventilated hospitals, that death results from the effectual and almost immediate poisoning of the system, before the local disease has progressed to any extent.

PROGRESS AND CHARACTER OF THE LOCAL CHANGES.

In many cases of gun-shot wounds, which subsequently became gangrenous, the attention of the wounded man was first called to the injured parts, by severe and darting pains in the wounds. These pains were sometimes compared by the Confederate soldiers to the pricking of ten thousand needles.

In other cases, the early stages of the disease were announced by a stinging or itching sensation; whilst in some cases there was little or no change in the sensation of the parts.

In some cases, in the earliest stages, the wounds presented a dark-red glazed surface; the granulations became altered in appearance, and rapidly disappeared; the discharge of healthy pus disappeared and was followed by a reddish and greenish sanious foetid discharge. The parts around the wound became painful and swollen, and frequently a well-defined red and purplish indurated border in the sound skin surrounded the wound. The wound itself rapidly assumes a swollen, ragged appearance (the gangrenous matter often rising several lines above the surrounding tissues), with swollen ragged, everted edges. With the infiltration of the diseased structures, and the consequent elevation of the surface and eversion of the edges of the wound, the glazed, dark-red appearance of the wound disappears, and the gangrenous mass presents a greenish and grayish color.

When the wounds were extensive, the gangrene would frequently appear in one or more circumscribed spots of a dark-gray and greenish color, and gradually spread over the entire surface and destroy the surrounding tissues. I have seen extensive ulcerated surfaces, in which the gangrenous parts remained almost stationary, whilst the surrounding portions of the wound presented a bright, florid appearance.

In cases of amputation, in patients whose systems were depressed and deranged by bad food and foul air, as in the case of prisoners in filthy, crowded military and civil prisons, hospital gangrene frequently made its appearance, in the wounds, in from twenty-four to seventy-two hours; and in such instances, the

first symptoms of the disease were manifested in the absence of any adhesive effusion, or inflammation, the swelling of the flaps, the rapid tearing out of the sutures, and the appearance of a deep blue and purplish discoloration of the skin around the edges of the wound. During the active stages of hospital gangrene, the surrounding parts are swollen and infiltrated with serum, and the temperature of the parts immediately around the diseased structures is elevated somewhat above that of the parts beyond.

As far as my observations extend, the serous fluid infiltrating the tissues, is liquor-sanguinis, and is capable of coagulation. The blood-vessels surrounding a gangrenous wound are always engorged with blood, as if the capillaries had lost their power to contract; and if an incision be made around the wound, in the unbroken skin, those distended vessels bleed freely. I have noticed in several cases of severe gangrene, that after serious hæmorrhage, the recovery of the patient was very rapid, as if the emptying of the surrounding engorged vessels had contributed to the rapid improvement of the wound.

The deep purple and blue color of the skin surrounding gangrenous wounds which are spreading rapidly, appear to be due to the want of oxygenation in the blood, and also to the fact that this blood is altered and contaminated, and in fact poisoned by the neighboring gangrenous matter. The deep blue and purplish color in the surrounding skin, is one of the most infallible signs of the active progress of the disease. After the disappearance of the gangrene, the blue and purple border either disappears entirely, or else fades away.

When the system has been thoroughly poisoned by the absorption of the gangrenous matter from a large wound, and by the constant inhalation of the foul atmosphere of the crowded ward, I have, in a number of instances observed parts removed from the immediate wound, but generally upon the same limb, take on the gangrenous inflammation, and that, too, without any apparent cause as pressure.

In such cases, a purple or blue spot is first perceived, or the color might more properly be termed, in some cases, an ash-gray or leaden hue. The cuticle is sometimes raised and contains serum below. The rapidity of the progress of the gangrene in

such spots, will depend chiefly upon the extent to which the system has been poisoned by the absorption of the deleterious matters. I have seen the skin in the affected spot melt away in twenty-four hours, into a grayish and greenish slough, whilst a deep blue and purple, almost black areola surrounding the dead mass, spread rapidly in ever widening circles, whilst the skin and tissues within over which it had just passed changed rapidly to the ash-gray and green and bluish hue characteristic of this form of gangrene. This is witnessed most generally in the worst and fatal cases. In some cases the gangrenous slough presents a black hard crust, which can only be removed by poultices. As long as the crust remains, the case progresses unfavorably. And, in fact, as far as my experience extends, these are amongst the most inveterate and obstinate cases.

Hospital gangrene destroys the cellular and adipose tissues most rapidly; the muscles, nerves, large blood vessels and the bones resist its action for a greater length of time. It is not uncommon to see large surfaces of muscles and even bones exposed, the skin and cellular tissue having been completely dissected away by the disease. The blood vessels yield more readily in *hospital* than in *dry* gangrene, and hence in the former, hemorrhage, both venous and arterial, is very common, and in some cases, both directly and indirectly becomes a cause of death. From this cause it happens that the gangrenous tissues frequently presents a mottled appearance from the hemorrhages of limited extent taking place from the smaller vessels destroyed in the ravages of the disease. Whilst there is a tendency to the coagulation of the blood in the vessels passing into and through the gangrenous mass, still the tendency is less, and the coagulation far less perfect than in dry gangrene. This difference may be due to the more rapid progress of the disease, as well as to differences in the quantity and quality of the fibrous element in the different forms of gangrene.

As far as my observations extend, the bones do not yield readily to hospital gangrene, and even when exposed, and in part surrounded by the disease, with the exception of slight exfoliation of the outer table, little or no erosion or death takes place; and when the disease is arrested, granulations spring up rapidly and cover the diseased surface of the bones.

Several instances have come under my observation, in which gangrene existed in structures beneath an apparently sound skin. Thus, in the case of a federal prisoner, who received a slight wound upon the external portion of the left thigh, just above the knee-joint, at the battle of Chickamauga, and who suffered for several days before death with an abscess in the groin of the injured limb, from which sanious fœtid matter issued, and who died, apparently, from the exhaustive effects of colliquative diarrhœa, resulting, apparently, from the absorption of the products of the disorganizing tissues, the skin over the injured thigh and buttock appeared sound, whilst the cellular and muscular tissues of the thigh and buttock were in a state of gangrene, presenting blue and green and greenish grey disorganized matter. In this case, the muscular structures were so disorganized that they were crushed by the slightest pressure. Under the microscope, the muscular substance and structures appeared to be almost completely disorganized, and nothing but the fibrous tissue remained. Innumerable granules and granular masses, crystals of the coloring matter of the blood, prismatic crystals of the phosphates of ammonia, magnesia and lime, altered blood corpuscles, detached masses of cellular tissue and of muscular fibres, in which the striæ were fast disappearing, together with oil globules, all pervaded by a fœtid, greenish, sanious fluid, constituted the mass of the gangrenous muscles. The disorganized structures were strongly impregnated with ammonia, one of the products of the disintegration of the nitrogenized constituents, and the normal acid reaction of healthy muscular structures, was charged to a strongly alkaline reaction.

In another case where this operation of ligating the bronchial artery was performed to arrest hæmorrhage from a gangrenous wound in the fore-arm, involving structures around the elbow-joint, the cellular tissue surrounding the artery was found to be in a gangrenous state, although no suspicion was entertained of the existence of gangrene, before the operation was performed. It is probable that in this case the spread of gangrene had been very rapid along the fibrous tissue surrounding the great vessels and nerves.

In a case of typhoid fever, treated in a gangrene ward, in the

midst of patients suffering from hospital gangrene, during convalescence from the fever, a painful swelling appeared upon the margin of the perinaeum and left buttock. The skin over the affected part assumed a bluish ash-color and the lancet passed readily through the dead integuments and tissues, and a large quantity of dark, grumous, tar like gangrenous matter, of a most offensive smell, flowed out. The odor was so offensive that it was almost impossible for the attendants to remain in the tent. After the evacuation of the dark-foetid matters, the structures within presented the general appearance of hospital gangrene and not of an ordinary abscess. The spread of the gangrene was rapid and distressing in this case.

I have frequently seen a narrow strip of apparently sound skin passing between two gangrenous wounds and even passing across a large gangrenous mass.

When gangrene terminates favorably, the surface from which it is removed, presents a bright red and scarlet exquisitely sensitive mass of luxuriant granulations, which are highly vascular, and bleed upon the slightest touch. So sensitive is this surface, that the slightest touch will frequently cause the patient, even though he may be a stout brave soldier, to cry like a child. Although the appearance here described is highly favorable, at the same time many cases terminate fatally even after the removal of the gangrene, from various causes; as exhaustion of the system by profuse suppuration, the depressing effects of the previous disease, the permanent derangement of the digestion caused during the active stages of the disease, by bed sores, by pyæmia, and by diarrhœa.

After the establishment of healthy granulations, the bones which have been denuded by the gangrene, will frequently be rapidly covered by a luxuriant growth of granulations. When the bones of the leg have been denuded in a stump, after amputation, I have observed a most luxuriant crop of granulations sprouting out of the medulla of the bone like a fungous growth. In most cases these granulations die, and the injured bone exfoliates. When the bone has been exposed in its length, the outer table will frequently scale off, and the destruction of bone proceeds no further, and the new tissue form over the denuded bones.

As the disease progresses, the complexion assumes an unhealthy, dusky, leaden hue, the eyes express anxiety, depression and nervous irritation and exhaustion, the pulse becomes small, frequent and feeble, and indicates an irritable, enfeebled state of the nervous and muscular systems. It is possible, by these symptoms alone, to decide, in many cases, whether gangrene is present, and whether it is progressing or disappearing.

In some cases the progress of the disease is rapid and terrible. The edges of the wound become hardened and everted, the surface of the wound rises up into a pulpy, ragged, grey and greenish mass. When the sloughs are detached the disease attacks other adjacent structures from day to day, extending its ravages both in length and breadth, involving aponeuroses, muscles, bloodvessels, nerves, tendons, the periosteum, and bones and joints.

Most commonly after the muscles have been exposed, they continue to be gradually dissected; their connecting membrane is completely destroyed, and they are left, covered with an offensive, greasy looking matter. When a muscle has been invaded by the disease, it sometimes swells to a great size, loses its irritability, and assumes the appearance of a large, purple and greenish coagulum. As the disease advances, hæmorrhage from small vessels is a common occurrence, and in the more advanced stages, some of the large vessels give way and the patient is frequently destroyed by the consequent hæmorrhage. Colliquative diarrhœa caused by the absorption of the gangrenous matters, is a frequent cause of death.

Microscopical Examination of the Gangrenous Matter : Consists of the various structures in a disorganized state, together with the products of the dead disorganized tissues. The pus globule absent in the gangrenous mass. The appearance of the pus-globule in hospital gangrene a favorable sign. Animalcules present in considerable numbers in the gangrenous matter.

I have made numerous microscopical examinations of the gangrenous matter, and discovered that it consists of various structures in a disorganized state, together with the various products resulting from the altered physical and chemical compounds. Innumerable granules are observable, with detached masses of

fibrous and muscular tissue, broken bloodvessels, disorganizing blood corpuscles, and in some cases, especially when strong mineral acids have not been applied to the gangrenous wound, crystals of the triple phosphate. Animalcules of simple organization and endowed with active rotary motions, abound in hospital gangrene. After a careful examination of various vegetable and animal matters exposed to the atmosphere, under similar circumstances of temperature and moisture, I have come to the conclusion, that in the present state of our knowledge we are unable to demonstrate that these animalcules are in any way connected with the origin and spread of hospital gangrene. The gangrenous matter appears to afford a nidus in which these simple forms of animal, and even of vegetable life are rapidly generated and multiplied. As far as my observations extend, they show that these animalcules will be generated with similar rapidity in urine containing albumen, or in any nitrogenized body undergoing putrefaction, in a warm, moist situation, like that of the wards of a hospital. The warmth of the human body, also without doubt, affords a most favorable condition for the rapid development of the simple forms of animal life. I have been unable to discover any forms of animalcule peculiar to hospital gangrene.

With reference to the simpler forms of vegetation, they are also present, but in less abundance than those of animal life; and in like manner these vegetable organisms are not peculiar to hospital gangrene, but are found in all organic matter undergoing decomposition under similar circumstances.

I have been unable to establish any relation between the rapidity of the spread of the disease, and the number and character of the living organisms; and have even found them absent in the most extensive gangrene, which had been excluded by the sound skin from the atmosphere. These microscopical investigations, therefore, have thus far afforded only negative testimony upon the animalcular origin of hospital gangrene.

I have determined, by careful microscopical examination, that the pus globule is not formed in true gangrenous matter. We do not wish to be understood as asserting that pus is never present in a gangrenous wound. It frequently happens that gan-

grene may exist in certain portions of a wound, whilst in other parts the reparative process is active. So also portions of the structures may resist for a time complete death, and whilst passing into a state of gangrene, present some of the changes of inflammation, one of which may be an altered or imperfectly developed pus. In the healthier portions of a gangrenous wound, we may therefore have the formation of pus, whilst in the gangrenous mass, this evidence of the organizing force is absent, or only accidentally present.

After gangrene has set in, the reappearance of pus should be regarded as a favorable sign, indicating an attempt at organization, and an improvement in the plastic powers of the parts immediately surrounding the altered gangrenous matter.

In the local manifestation of the actions of many organic poisons, of siccens or sicens, of jaws and of various skin diseases the formation of pus is invariably observed. Even in the phagedenic ulcers arising from the abuse of mercury in constitutions worn down by viscious habits, deteriorated by the abuse of alcoholic stimulants and bad diet, and poisoned by the syphilitic virus, the spread of ulcerations and the detachment of the tissues is attended with the constant formation of pus. Whether we view this fluid, as resulting from the degeneration of the affected fluids and tissues in these diseases; or as analogous to a secretion thrown out by the parts surrounding the immediate focus of the inflammation, destined to dissolve the diseased tissues; or as one of the natural stages of the changes of coagulable lymph, and of granulation cells, in the progress of inflammation: it is nevertheless true, that the absence of pus in any wound or ulcer which is rapidly enlarging its bounds, indicates marked derangements in the changes of the solids and fluids, and in the action of the forces concerned in ordinary inflammation. Whilst inflammation is justly called a diseased action, and is incessantly attended with derangements in the constitution and forces of the affected parts, and in the processes of nutrition and secretion; at the same time, inflammation is governed by definite laws, and often progresses in such a manner, as to preserve the life of an animal, and the functions of the part inflamed; therefore uniform perturbations of the process as ordinarily observed, indicate clearly the action

of some definite cause. And hence also we may speak of a derangement of even the changes characteristic of inflammation.

If we accept the definition that inflammation is "an alteration in the healthy structure and function of a part, accompanied by a perverted condition of the blood and capillary blood vessels; ordinarily attended with redness, heat and swelling; and inducing more or less febrile disturbance in the general system;" then in hospital gangrene we observe all the essential conditions of inflammation. In this disease, there is an alteration in the healthy structure and function of the affected parts, as indicated by the change of color and structure, the foetid odor, and the suspension of secretion and healthy nutrition; there is an altered condition of the blood as manifested by the dark, livid areola, by passive hæmorrhages, and by the dusky hue of the complexion; there is derangement of the capillary circulation, as manifested in the effusion in and around the gangrenous tissues and the intense congestion of the blood-vessels in immediate contact with the diseased parts; there is redness, pain, heat and swelling; and there is more or less febrile disturbance of the general system, as manifested in the rapid feeble pulse, the marked diurnal elevations and depressions of temperature, the depressed spirits and deranged muscular and nervous actions.

When the injury of the living tissues is simple, as in the wound caused by a mechanical instrument, the natural result of inflammation appears to be the production of such a fibrinous effusion as will surround and isolate the injured or diseased parts. In such uncomplicated cases of the inflammatory process, there will be observed in the injured structures, the perversion of nutrition, the destruction of capillaries, the alteration of the blood, the exudation of lymph and the formation of pus; and around the focus of actual destructive changes, the blood-vessels are distended with blood and exude the plastic lymph, from which the coagulable elements separate, containing the germ cells, destined not merely to form a structure inclosing the diseased parts, but also by their development to form a tissue which will replace that which has been destroyed. The living cells of the lymph may either form tissue, or granulations, or they may be arrested and altered in their development and form the pus globule. With regard to

the vital properties of coagulable lymph, its essential character, is its power to develop itself and assume organic structure. We should regard pus, on the one hand, as a secretion destined to dissolve certain organic tissues, and to shield by its bland properties delicate granulating surfaces from the direct action of the atmosphere; and on the other hand as a rudimental imperfectly developed, or degenerated substance, essentially similar to the materials of the lymph of inflammatory exudation, or of granulations, but which has either failed of being developed like them, or which has degenerated after a certain amount of development.

In hospital gangrene, the lymph effused around the focus of disease, possesses the power of coagulation, as in other varieties of inflammation, as I have determined by actual experiment; and there appears to be all the conditions necessary for the arrest of the disease by the development of coagulable lymph through nucleated cells into the fibrous and fibro-cellular or connective tissue; but the characters of the irritant poison are such, that the products of inflammation, together with the blood-vessels and the blood itself are rapidly disintegrated. The life of the blood is destroyed by the gangrenous poison, and the fluids and living organizable matter and cells, upon which the progress of inflammation depends are poisoned. It results from this, that the liquor-sanguinis effused within the diseased structures does not pass into the state of pus, as in healthy wounds, and in the common furuncle and carbuncle, or even in erysipelas and the pustules of small pox, and the exudation corpuscles are so poisoned and disorganized that they are not further changed in either a progressive or descending series, and wherever the limiting fibrinous wall is thrown out with its cellular elements, it is in like manner destroyed whenever it is reached by the poison. All the changes of the blood characteristic of ordinary inflammation may be present around the gangrenous parts; as the increase of liquor-sanguinis, with increase of its albumen and fibrin, both actually and relatively to the blood corpuscles, aggregation of the red corpuscles, and increase of the colorless or lymph corpuscles, but no arrest of the disease will take place, as long as the poison is capable of exciting rapid chemical change and decomposition, after the manner of a nitrogenized ferment in the products of inflammation.

If in a wound infected with hospital gangrene, the morbid process did not advance, as in any other wound, from the centre to the circumference, with the central focus of infection and active disorganization surrounded and guarded as it were by a circle of active congestion, with blood-vessels loaded with colored corpuscles, with interrupted circulation and exudation of plastic liquor-sanguinis, and [with venous and lymphatic absorption greatly impeded, if not altogether arrested; the gangrenous poison would enter directly and rapidly into the circulation and prove rapidly fatal. And even after the excitation of inflammation, in virtue of the irritant properties of the poison, in every case of hospital gangrene of any standing, more or less of the poison is absorbed and effects the general system. The extent of this absorption of the deleterious agent or agents, will depend upon many circumstances, but chiefly upon the character and extent of the inflammatory process around the immediate centre of infection.

We may in these facts find some explanation of the relief sometimes afforded by hæmorrhage in hospital gangrene. The poison is diluted and washed out by the blood, at the same time that the inflammatory congestion is relieved by the hæmorrhage.

From the disintegration of the organic constituents of the structures in hospital gangrene, a number of compounds result, which are either unknown, or are very rare in the living organism. Some of these products when absorbed, act as animal poisons upon the muscular and nervous systems, and tend to disorganize the blood and derange the actions of the alimentary canal. When absorbed in large quantities, these products sometimes act as irritants to the intestinal canal, and the patients are sometimes destroyed by the diarrhœa consequent upon their action.

The extent of these changes is well illustrated by the fact which I have demonstrated by microscopical and chemical investigation, that ammonia is sometimes generated in such large quantities in gangrenous muscles, as not only to give a strong alkaline reaction to the naturally acid muscular juices, but also to cause the precipitation of the phosphates in the form of well-defined crystals of triple phosphate.

The results of these microscopical observations, clearly sustain

the view; that hospital gangrene is due to the action of an irritant organic poison, which, after the manner of a ferment, is capable of inducing such decomposition in the tissues and in the blood, that all developments of the cellular elements of the liquor-sanguinis into cells, fibres or into pus, is arrested.

CHANGES OF THE BLOOD IN HOSPITAL GANGRENE.

In this disease, it would be manifestly improper to abstract blood by venesection simply for analysis, when the lancet wound would be liable to be attacked by gangrenous inflammation and the life of the patient might be sacrificed. This danger was specially to be dreaded in the crowded Confederate hospitals, scantily supplied with lint, rags, utensils and instruments. My investigations, therefore, have been necessarily limited to the examination of the blood collected during hæmorrhages and amputations.

The first and most important subject of investigation, in the relations of the changes of the blood in this disease, which we endeavored to elucidate, was the character and quantity of the fibrin. The determinations of the variations of the fibrin, appeared to be of the first importance, because of the relations which the quantitative and qualitative changes of this constituent of the blood bear to the phenomena of the two great classes of disease—the phlegmasiæ and the pyrexia. We have drawn up the following table of the proportions of fibrin in various diseases, that we may be able, as far as this constituent of the blood is concerned, to determine whether hospital gangrene should be classed with the phlegmasiæ.

TABLE of the Fibrin in 1000 Parts of Healthy and Diseased Blood:

Observers.	Diseases.	Remarks.	Fibrin in 1000 Parts Blood
Andral & Gavarret	Standard of Health	{ In Healthy Blood the Fibrin may vary from	2.00 to
Becquerel & Rodier			3.50
Joseph Jones	Hospital Gangrene	Mean of five cases	3.86
" "		Maximum	6.03
" "		Minimum	2.10
" "		First Case	4.02
" "		Second "	6.03
" "		Third "	2.10
" "		Fourth "	3.04
" "		Fifth "	4.11
Becquerel & Rodier		Mean of Numerous Obs.	5.80
" "		" First Bleeding	7.30
" "		" Second "	6.80
Andral & Gavarret	Phlegmasiæ Generally	Mean of 58 Analyses	7.30
" "		Maximum of 58 Analyses	10.50
" "		Minimum " "	4.00
" "	Pneumonia		

Observers.	Disease.	Remarks.	Form to read page 10 and 11
Andral & Gavarret	Pleuritis	Mean	4.65
" "	" "	Maximum	5.00
" "	" "	Minimum	3.80
Becquerel & Rodier	Acute Bronchitis	Mean of five Cases	6.10
" "	" "	Mean of four Cases	4.80
Andral & Gavarret	" "	Maximum of six Cases	9.30
" "	" "	Mean of	5.30
" "	Angina Tonsillaris	Mean of	5.85
" "	" "	Maximum of	7.30
" "	" "	Minimum of	4.80
" "	Acute Rheumatism	Mean of 43 Cases	6.70
" "	" "	Maximum of 43 Cases	10.20
" "	" "	Minimum of	2.80
" "	Chronic Rheumatism	Mean of ten Cases	5.80
Becquerel & Rodier	Articular Rheumatism	Mean	5.80
" "	Puerperal Fever	Mean of four Cases	5.16
Heller	(matism)	" "	5.16
Popp	Febril Arthritic Rheu	Female aged 20, 1st bl'dng	11.49
" "	" "	" "	12.97
" "	" "	Male aged 22, 1st bleeding	11.40
" "	" "	" " 2d	7.91
" "	" "	" " 3d	9.25
" "	" "	Female, aged 20	13.34
" "	Glanders	" "	8.35
" "	" "	" "	10.48
" "	Inflammation of Brain	" "	6.40
" "	" "	" "	6.30
" "	Erysipelas	Man, aged 33 years	6.60
Andral & Gavarret	" "	Mean of eight Analyses	5.67
" "	" "	Maximum of	7.30
" "	" "	Minimum of 8	3.60
" "	Eithias	Mean of twenty-one Cases	4.40
" "	" "	Maximum of 21	5.90
" "	" "	Minimum of 21	2.19
Becquerel & Rodier	" "	Mean of	4.80
Gibson	Scrophula	Mean of 8 Cases, Males	3.13
Heller	Carcinoma	Mean of seven Cases	6.54
" "	" "	Maximum of seven Cases	16.44
" "	" "	Minimum of	3.30
Wittstock	Cholera	One Case	11.00
Smith	" "	" "	11.10
Becquerel & Rodier	" "	Man, day of Death	1.78
" "	" "	" "	6.50
" "	Bright's Disease, Acute	Mean of 15 Cases	2.80
" "	" " Chronic	Mean of 13	4.34
" "	" "	Mean of 6	4.20
" "	" "	Mean of 10	3.72
Joseph Jones	Diabetes Mellitus	" "	2.00
Becquerel & Rodier	Acute Scurvy	Man aged 48, sick 42 days	2.00
" "	" "	" " 21	1.20
" "	" "	" " 32	1.85
" "	" "	" " 23	1.32
Andral & Gavarret	Small Pox	Mean of five Cases	2.40
" "	" "	Maximum of five Cases	4.40
" "	" "	Mean of four Cases	1.10
" "	Scarlatina	Mean of	4.35
" "	Measels	Mean of nine	2.74
Joseph Jones	Malarial Fever	Mean of	2.61
" "	" "	Minimum of	2.00
" "	" "	Minimum of	1.75
" "	" "	Int rm nt fever of 12 days	1.56
" "	" "	" " 2 weeks	2.54
" "	" "	" " 6 weeks	1.92
" "	" "	Remittent fever of 16 days	2.93
" "	" "	" " of 10	1.43
" "	" "	Remit. & Typhoid 11	2.38
" "	" "	Remittent fever 2 weeks	2.71
" "	" "	Consecutive Fever	0.87
" "	" "	Congestive fever	1.45
Andral & Gavarret	Typhoid Fever	Mean of 41 Analyses	2.99
" "	" "	Maximum of 41 Analyses	4.80
" "	" "	Minimum of	0.99
M H Hammond DeMunsey and M. Rodier	Typhus Fever	Mean of six Cases	2.46
" "	" "	Maximum of six Cases	3.90
" "	" "	Minimum	1.20

The first case of hospital gangrene, in which we examined the blood, was of the gravest character: the diseased action involved a large portion of the arm and fore-arm, and the elbow-joint was opened by the extensive ravages of the gangrene. The case terminated fatally after slight hæmorrhage from the brachial artery.

The action of the gangrenous poison upon the general system; the feeble rapid action of the heart; the great changes of temperature; the depressed, enfeebled, nervous and muscular forces; the trembling hands; the low, muttering delirium; the trembling eye-balls and quivering features; the insensibility of the organs of sense; the derangement of digestion, and the fœtid diarrhœa; the dusky, sallow hue of the complexion, and the livid, blue color of the tongue, were manifestly due to derangements induced by the gangrenous poison in the constitution of the blood, in the capillary circulation, and in the processes of nutrition, secretion and excretion. The blood appeared to have lost, in a great measure, its power of absorbing oxygen; and were the process of analysis sufficiently exact, and comprehensive, it might have been possible to have detected the gangrenous poison, or the products of its action in the blood. The intestinal canal appeared also to eliminate considerable quantities of the offending matter from the blood.

In this case the fibrin was slightly increased above the standard of health, being 4.02 parts in one thousand parts of blood, whilst in healthy blood, the fibrin may vary from 2. to 3.5 in the thousand parts. It was below the standard observed in the phlegmasiæ generally. Thus, according to Andral and Gavarret, the mean of 58 analyses of the blood of pneumonia, gave 7.3 parts of fibrin, with a minimum of 4. and a maximum of 10.5; in pleuritis, mean of 5 analyses 6.1; and according to Becquerel and Rodier, the standard for the phlegmasiæ generally, as determined by numerous observations, is 5.8.

In this case the fibrin was increased above the standard usual in idiopathic fevers. Thus, in nine cases of malarial fever, I found the fibrin to range from 0.877 to 2.938, with a mean in the thousand parts of blood of 2.018; in marsh cachexy, induced by the malarial poison, Becquerel and Rodier found, in five cases, the fibrin to range from 2.26 to 4.27, with a mean of 3.49; Andral and

Gavarret, in 41 analyses of the blood in typhoid fever, give the minimum of the fibrin as 0.9, the maximum 4.2, and the mean 2.6; in typhus fever, according to M. H. Guenard de Mussey and M. Rodier, maximum 3.9, mean 2.446, and minimum 1.2.

The fibrin was increased above the standard for small pox, as determined by Andral and Gavarret: mean of blood of five cases of small-pox, 2.4, maximum 4.4, minimum 1.1. It was less than that of scarlatina, according to the same observers: mean of four cases, 4.35, maximum 6.8, minimum, 3.1. It was somewhat greater than that of measles: mean of seven cases of measles (Andral and Gavarret) 2.742, minimum 2.4, maximum 3.4.

It is also important to note that this constituent of the blood was in larger amount than in acute or chronic scurvy: thus, according to Becquerel and Rodier, the fibrin in one thousand parts of the blood of a man, aged 48 years, sick with scurvy forty two days, was 2.5; in a man aged 24 years, sick thirty days, was 2.2; in a man aged 22 years, sick 445 days, 1.85; in a man aged 23 years, sick 553 days, 1.32.

As far as my observations have extended, there is no necessary connection between hospital gangrene and scurvy. The two diseases may exist together, and hospital gangrene appears to commit most frightful ravages in scorbutic patients, but they are not related to each other as cause and effect. This observation is still farther sustained by the fact that the remedies best adapted for the cure of scurvy, exert little or no effect upon the progress of hospital gangrene; and I have seen hundreds of cases arising in men in whom no sign of scurvy was present. When the two diseases exist in the same individual it is undoubtedly true, that it is difficult to eradicate and cure the hospital gangrene, until the scurvy has been removed by a proper course of treatment and diet; but this fact does not at all establish any identity, or even relationship, between the two diseases.

It is also worthy of consideration, that the fibrin was increased to a much less extent than is usual in erysipelas: thus, Popp found this constituent to exist in the blood of a man suffering from erysipelas, in as large a proportion as 6.6; and Andral and Gavarret in eight analyses of the blood in this disease, determined the mean to be 5.67, minimum, 3.6, maximum 7.3. Some have supposed

that hospital gangrene was intimately related to erysipelas, this fact, however, together with the absence of pus in the former, and the rapid and almost invariable and abundant formation of this result of the inflammatory process in the latter, demonstrates that the two diseases are distinct.

Finally, the results of the examination of the blood in this case, sustain the view that the essential conditions of inflammation are present in hospital gangrene.

In the second case the fibrin amounted to 6.03 parts in the thousand of blood.

This soldier after suffering with gangrene in a gun-shot wound of the neck, which extensively denuded the muscles on the left side above the scapula, was suddenly seized with a slight hæmorrhage from the internal jugular vein, which was followed by such complete prostration of the muscular and nervous forces, and such loss of power and variation in the action of the heart, that the gravity of the symptoms could only be accounted for on the supposition that air had entered the venous system.

The patient, who was sitting up at the time of the occurrence of the hæmorrhage, was immediately seized with great difficulty of breathing, loss of muscular power, irregular, thumping action of the heart, and total cessation of the pulse; although the hæmorrhage was very slow, as if issuing from a vein, and insignificant in amount, and promptly arrested upon the application of a solution of per-sulphate of iron, and he lay with eyes fixed, gasping for breath, unable to articulate, with cold purple hands and lips, as if in articulo mortis, and finally died in about eight hours after the hæmorrhage.

A careful post-mortem examination revealed the fact, that death had been caused in this case, by the entrance of air into the internal jugular vein, through the erosion caused by the gangrene. Nature had (if we may use the expression) made great efforts to repair, by a fibrinous clot, the ravages of the gangrene, but had not been entirely successful.

The fibrin, although the gangrene was rapidly disappearing, was above the normal standard. It is worthy of notice that the fibrin was more abundant in this case, in which there were little

or no constitutional symptoms, than in the preceding case, when the blood had been evidently altered and poisoned by the virus and its products.

In the third case in which the arm had been amputated from the effect of hospital gangrene, and which was attended with a profuse sanious fetid discharge from the stump (the case terminating fatally from hæmorrhage), the grave constitutional disturbances were attended with a decrease of fibrin below the standard of health, this constituent being only 2.1 parts in the thousand of blood.

In the fourth case in which the structures of the leg were so extensively involved and the strength of the patient so completely drained by the exhausting and unhealthy discharges, as to necessitate amputation at the lower third of the thigh; the fibrin was 3.04 parts, and was within the limits of health, as far as its quantity was concerned. In so extensive an inflammation of the structures of the leg as this patient was laboring under, we should naturally look for an increase of the fibrous element of the blood. We are justified by the whole history of this case, in believing that there was some cause or combination of causes which hindered the increase of fibrin usual in such cases of inflammation. The profuse discharge from the affected limb, as well as the absorption of the products of the disorganized tissues may have had much to do with restraining the increase of the fibrous element of the blood.

In the fifth case, gangrene committed such extensive ravages in a gun-shot wound of the foot, as to penetrate the ankle-joint and expose the bones and tendons of the leg, and to necessitate amputation below the knee-joint, on account of the great loss of tissue, the carious constitution of the bones, and the progressive exhaustion of the strength of the patient.

As in the preceding cases, the blood collected during the amputation, coagulated firmly, but the clot changed more slowly and less perfectly to the arterial hue upon the surface, than in the blood of health. The fibrin was 4.11 in the thousand parts, and was increased somewhat above the standard of health, but was below that of the phlegmasiæ.

From the preceding observations we conclude—

1. *The action of the poison of hospital gangrene is attended with both local and constitutional symptoms of inflammation.*

Thus within the focus of active change and disintegration, there are alterations in the healthy structure and function of the affected parts, as indicated by the change of color and structure, the fœtid odor, and the suspension of secretion and healthy nutrition, by the altered condition of the blood, as manifested in the surrounding dark livid areola, by passive hæmorrhages and by the rapid decomposition of this fluid; and around the focus of active disintegration there is active determination of blood, congestion of the capillary blood-vessels, accumulation and stagnation of the colored blood-corpuscles, relative and absolute increase of fibrin, albumen and colorless corpuscles, effusion of coagulable lymph, and redness, heat, swelling and pain. In the general system there is increase of fibrin in the blood, and more or less febrile disturbance, as manifested in the accelerated circulation, increased temperature and deranged muscular and nervous actions.

2. *The changes excited both locally and constitutionally by the gangrenous poison, are such, that the products and phenomena of the disease vary to a certain extent from those of ordinary inflammations.*

Thus in hospital gangrene, the lymph effused around the focus of disease possesses the power of coagulation and development into tissue, and there appears to be all the conditions necessary for the arrest of the disease, by the development of coagulable lymph through nucleated cells, into the fibrous and fibro-cellular or connective tissue; but the characters of the irritant poison are such, that the products of inflammation, together with the blood vessels and the blood itself, are rapidly disintegrated, the life of the blood is destroyed by the gangrenous poison, and the fluids and living organizable matter and cells, upon which the progress of inflammation depends, are poisoned. It results from this, that the liquor-sanguinis effused within the diseased structures, does not pass into the stage of pus as in healthy wounds and in the common furuncle and carbuncle, or even in erysipelas and the pustules of small pox; and the exudation corpuscles are so poisoned and disorganized, that they are not farther changed either in a progressive or descending series, and wherever the

limiting fibrous wall is thrown out, with its organizable cell elements, it is in like manner destroyed when it is reached by the poison. All the changes of the blood characteristic of ordinary inflammation may be present around the gangrenous part; as the liquor sanguinis, with increase of its albumen and fibrin, both actually and relatively to the blood corpuscles, aggregation of the red corpuscles, and increase of the colorless and lymph corpuscles; but no arrest of the disease will take place, as long as the poison is capable of exciting rapid change and decomposition, after the manner of a nitrogenized ferment, in the products of inflammation.

3d. The gangrenous poison, as well as the compounds resulting from the disintegration which it induces in the organic constituents of the structures, when absorbed, acts as a poison upon the muscular and nervous systems, and tends to disorganize the blood and derange the actions of the alimentary canal.

When absorbed in large quantities these products frequently act as irritants to the intestinal canal, by which they are eliminated, and patients are sometimes destroyed by the diarrhoea consequent upon this action upon the intestinal mucous membrane. The absorption and consequent action of the gangrenous poison upon the general system, is manifested by the feeble rapid action of the heart; the marked elevations and depressions of temperature; the depressed enfeebled nervous and muscular forces, the trembling hands, the low muttering delirium; the trembling eyeballs and quivering features, and the insensibility of the organs of sense, and by the derangement of digestion and the foetid diarrhoea.

The derangements induced by the gangrenous poison in the constituents of the blood, and in the capillary circulation are manifested by the dusky, sallow, livid and leaden hue of the complexion, the livid blue color of the tongue, the derangements of nutrition, secretion and excretion, diminution in the power of the colored corpuscles to absorb oxygen from the atmosphere, and by the partial increase of the fibrin, notwithstanding the presence of an inflammatory state. It appears therefore, that the fibrin is not increased in hospital gangrene, to the extent usual in ordinary inflammations, on account of the absorption and action of the poison producing the disease, and of the products of the

decompositions which it excites in the structures and fluids. A similar condition is observed in the action of the poison producing small-pox. In this disease also, as will be seen from the preceding table, notwithstanding the presence of both local and constitutional symptoms of inflammation, the fibrin is less than in complicated inflammation, or in pneumonia.

Variations of the temperature and circulation in hospital gangrene. Marked daily variations between the temperature of the trunk and extremities. Daily variations of the pulse. The observations upon the variations of the pulse and temperature of importance in their bearing upon the nature and treatment of the disease. Characters of the urine in hospital gangrene.

From a large number of observations upon individuals selected from over fifteen hundred cases of hospital gangrene, we were enabled to establish the following conclusions :

1st. The local manifestations of hospital gangrene, are attended by febrile action in the general system.

The fever of hospital gangrene, like that accompanying other diseases, is characterized by increase of heat, increased chemical change, and increased elimination of those substances, as urea, uric acid, phosphoric acid, sulphuric acid, and coloring matters which result from the destructive metamorphosis of the solids and fluids.

The fever appeared in many cases of hospital gangrene before the wounds had actually assumed the gangrenous state, with swollen everted edges and gray sloughing surface ; after careful investigation, it appeared to be more reasonable at this stage of the disease, to consider the fever as the *resultant* and necessary accompaniment of the earliest changes in the wound, than as the *cause* of the gangrenous inflammation. Simultaneously with the development of the fever, and the constitutional disturbances, characterized by loss of appetite, depression of spirits, constipation of the bowels, and such an enfeebled irritative action of the circulatory apparatus, as denoted a depression of the vital and nervous and muscular forces, certain local changes were noted in the wounds, as the transformation of the moist florid granula-

tions into a dark-red, glazed surface, a change or total suppression of the natural discharges of pus, increased heat and pain, and an increased congestion of the blood vessels in and around the wound.

2d. The fever of hospital gangrene appears to be manifestly the result of the action of an organic poison.

This proposition is sustained by the facts clearly established by the preceding investigations; viz: that gunshot wounds are not necessarily attended by fever; that the fever accompanies or follows the supervention of hospital gangrene in those cases of gunshot wounds, which up to this period had been unaccompanied by febrile excitement; and finally, that the complete separation of the ragged spongy gray sloughs, and the appearance of healthy granulations, and pus in the wound, and the arrest of the farther progress of the gangrene, are certainly attended, if not preceded by corresponding improvements in the constitutional symptoms.

After the removal of the gangrene and the establishment of granulation and suppuration, the pulse becomes fuller and slower, the diurnal variations of temperature less, the normal relations between the temperature of the extremities and central organs are re-established, the capillary circulation in the extremities becomes more active, and the appetite improves, the complexion loses its leaden, dusky, unhealthy hue, the eye expresses hope and life, and the distressed countenance becomes cheerful. Corresponding changes are observed in the urinary excretion: as the wound improves the urine progressively loses its high color, and the febrile characters, and approaches by gradual degrees to the standard of health. No crisis, or sudden change is observed in the urine during the period of convalescence, but the changes in this excretion correspond with the gradual changes of the wound.

In this respect, all the symptoms correspond, in that they all gradually and progressively improve, without any marked or sudden changes, as in certain diseases, as for example, in malarial fever.

The favorable changes just indicated, will frequently take

place, even when a most extensive surface is exposed and raw, as a large portion of the back, or of the buttock, or of the thigh, six or eight inches in diameter. The fact that all the constitutional symptoms may improve, even before the diminution of the size of the wound, and whilst a large raw surface, of muscles, nerves and blood vessels and bones remain exposed, demonstrates conclusively that the constitutional disturbances are not due exclusively or even in great measure to the local irritation of the nerves exposed by the gangrene.

When, on the other hand, hospital gangrene progresses unfavorably, the constitutional symptoms, become progressively more grave, and the fatal termination is generally announced by a feeble, rapid pulse, extreme prostration—twitching of the tendons, vomiting, hiccough, involuntary dejections, and oftentimes coma.

In this disease, death unquestionably results in many cases, from the absorption of the gangrenous matter. In this case the cause of death is often profuse and uncontrollable diarrhœa. The absorbed gangrenous matter may also in certain cases excite mortification of important internal organs. Such a change may take place rapidly, and without the manifestation of any symptoms, during the life of the patient, which indicate the presence of the disease.

We conclude, therefore, from these well established facts, that in every case of hospital gangrene, which terminates favorably or unfavorably, the character and extent of the constitutional disturbances, are due in a great measure to the absorption of deleterious poisonous matters from the wound.

3d. The febrile state of hospital gangrene is characterized by increased chemical change in the blood, and textures, increased development of heat above the standard of health, marked diurnal variations of temperature, great irritability and feebleness of the general circulation, and imperfect and feeble capillary circulation, as manifested by the marked difference of temperature between the trunk and extremities, and the inability of the extremities to maintain a definite temperature, and withstand the effects of external cold.

The periodical elevations and depressions of temperature, were intimately associated with the action of the heart. As a general

rule, acceleration of the heart's action, was attended with an increase of temperature, and decrease in the frequency and force of the heart's action, was attended with decrease of temperature. The temperature fell to the lowest point in the mornings when the action of the heart was slowest.

The decomposing poisonous matters, and the products of inflammation absorbed from the gangrenous wounds after their introduction into the circulatory system, cause derangement in the blood and excite increased chemical change and consequently cause an elevation of temperature. It is well known that increased heat, tends to excite and accelerate the heart's action. If the conditions remained the same, the introduction of a morbid material (capable of exciting change) into the blood should be attended by uniform results and uniform elevations of temperature. But in man the conditions are vastly varied during the different periods of the day.

During the day time he is subjected to the stimulus of light and to an increase of external temperature, all the faculties and functions are aroused, and as the day advances, the heart responds to the increased excitement of the nervous and muscular systems. During the period of rest at night, the conditions are changed, the wastes of the working hours are repaired during those of repose; the withdrawal of the stimulus of light and the removal of the incentives to nervous and muscular exertion, is attended with decreased action of the heart and reduction of temperature. During sleep also the respiration is not so full, and aeration of the blood is not so perfect. The skin also is relaxed, and the perspiration increased, and the reduction of the temperature by evaporation promoted.

The patient suffering from hospital gangrene, is under the action of a depressing organic poison, which alters the constitution of the blood, deranges the nutrition of all the organs, and renders the nervous system irritable and irregular in its action. The strongest men are reduced under the action of this poison, to the condition of weak, irritable children, being not only incapable of any great muscular exertion, but also of prolonged and vigorous mental efforts. The exciting agencies of the day,

produce in this state an irritable and accelerated action of the circulation; and on the other hand, during the depressed state of sleep, there is a rapid diminution of temperature.

We have in these characteristics of hospital gangrene, most valuable indications for treatment—the general system must be supported by tonics and stimulants and those measures instituted which will most effectually promote the elimination of all poisonous matters from the general system, and destroy them in the local disease, and at the same time improve the quality of the blood, strengthen and equalize the circulation and invigorate the nervous and muscular systems. The following table presents the relations of the pulse, respiration, temperature, and changes of urine in this disease:

Table of Observations on the Pulse, Respiration, Temperature, and Urine, in Hospital Gangrene: Consolidated from Observations of Joseph Jones, M. D., Surgeon, P. A. C. S.

EXPLANATION: 1st column—number of case; 2d—state of wound, P signifies Gangrene progressing; A signifies Gangrene arrested; 3d—hour of day; A. M.—morning observation; P. M.—evening observation, (these observations most generally at 8 A. M. and 8 P. M.); 4th and 5th—Pulse and respiration; 6th and 7th—temperature of hand and axilla; 8th, 9th, 10th 11th 12th—Urea, Uric Acid, Phosphoric Acid and Sulphuric Acid, and Chloride of Sodium, excreted in 24 hours, expressed in Troy grains.

Number of Case	State of Wound.	Hour of Day.	Pulse.	Respiration.	Temperature of Hand.	Temperature of Axilla.	Grains Urea in 24 hours.	Grains Uric Acid in 24 hours.	Grains Phosphoric Acid in 24 hrs.	Grains Sulphuric Acid in 24 hrs.	Grains Chloride of Sodium in 24 hrs.
1	P	P M	118	18	91.4	104.9	358	10.4	31.4	34.9	70.6
	P	A M	106	18	88.3	98.8					
	P	A M	84	18	89	100.7					
	P	P M	108	18	98.2	103.8					
2	P	P M	101	26	100.4	105.8					
	P	A M	94	28	95.	98.3	409	5.6	36.2	22.6	25.8
	P	P M	108	26	102.6	104.4					
3	P	P M	100	20	102.2	102.6					
	P	A M	100	24	101.1	101.3	682	10.32	68.8	49.8	13.2
	P	P M	104	28	102.2	104.2					
4	P	P M	100		85.	102.					
	P	A M	98		90.	100.					
	P	A M	100		93.5	100.5					
	P	P M	120		103.	103.5	600	16.14	40.6	37.6	130.8
	A	A M	100		85.	99.					
	A	P M	100		96.	99.5					
5	P	P M	124	20	105.7	106.1					
	P	A M	105	16	101.9	102.6					
	P	P M	134	21	108.5	105.1	506	3.	57.8	32.7	110.8
	A	P M			99.3	100.8	468	10.1	22.8	28.2	61.
6	P	P M	100	21	102.2	102.6					
	P	A M	100	18	99.	101.3					
	P	P M	120	28	100.8	102.3					
7	P	A M	80	16	88.	97.5	526	13.8	43.5	32.2	140.
	P	P M	98	18	101.1	102.5					
	A	P M	96	18	97.1	99.3					
	A	A M	80	18	88.1	98.9					
	A	A M	80	18	89.9	96.8	405	15.3	39.3	16.8	108.
	A	P M	88		84.	99.1	372	12.38	25.2	17.0	214.
8	P	A M	80	18	89.9	99.1					
	P	P M	86		88.1	99.3					
	P	A M	80	16	88.3	100.8					
	P	P M	80	16	89.8	102.3	388	13.5	31.7	19.7	77.6
	A	A M	80	18	86.	99.	492	18.37	39.4	26.8	86.2
	A	P M	80	18	84.	100.6	454	15.23	27.6	26.8	138.
9	P	A M	86		88.	98.9					
	P	P M	98		90.1	101.1					
	P	P M	96		100.7	102.2					
	P	A M	84	18	91.7	97.					
	P	P M	100	18	93.2	102.5					
	P	A M	80	18	86.3	100.4					
	P	P M	96	18	82.4	102.4	677	16.4	48.7	44.6	14.9

Table of Observations—Continued.

Number of Case.	State of Wound.	Hour of Day.	Pulse.	Respiration.	Temperature of Hand.	Temperature of Axilla.	Grs. Urea in 24 hrs.	Grs. Uric Acid in 24 hours.	Grs. Phosphoric Acid in 24 hrs.	Grains Sulphuric Acid in 24 hrs.	Grs. Chloride in 24 hrs.
11	P P M		108	18	108..	103.5	404	9.3	43.8	25..	19.3
	P A M		96	18	94..	101.75	785	22..	51..	53..	64.7
	P A M		94	18	90..	99..					
	P P M		108	18	108..	103.5					
	P A M		90		80..	100..					
12	P A M		100		95..	100..					
	P P M		120		99..	101.5	364	11.6	19.9	15.1	81..
	P A M		108		92.5	100..					
13	P A M		100		87.5	100..	361	16.8	28..	18..	62..
	P P M		104		88.5	101..					
	P A M		94		89..	100..					
	P P M		100		93..	101.5	486	16.8	31.6	21.6	203..
14	P A M		96	22	95.4	100.4					
	P P M		110	28	95..	102.2					
	P A M		116	22	93.2	100.4	203	4.9	11.0	11.5	18.4
	P P M		118	24	100.4	104..	324	9.8	41..	20..	32..
15	P P M		104	22	99..	102.6					
	P A M		98	18	91.4	100.4					
	P P M		106	16	100.8	104..	412	7.6	54.8	16.8	46..
	P A M		108	18	95..						
	P P M		108	18	99.3	104.8					
16	P A M		101	21	100.4	100.4					
	P P M		108	22	99.4	104..	303	9.12	17..	14..	8.8
	P A M		112	18	87..	99..	218	7.7	8.5	10.8	5.39
	P A M		92		99.15	102.4					
	A P M				99.4	101..					
	A A M		84		98.4	100.4					
	A A M		80		93.6	97.4					
17	A P M				95.3	97.5					
	A A M		80		93.6	97.4	353	16.5	23.9	14..	129..
	P A M		94	16	95.3	102.2	422	7.3	30.7	17..	180..
	P P M		100	16	98.6	101.1					
	P A M		88	16	97.1	101.1					
	P P M				98.6	102.3					
	A A M		80	16	96.9	99.3					
	A A M		84	16	92.1	196.6					
18	A P M				93.7	100.7					
	A A M		80	16	93.2	98.9					
	A A						498	14.8	40.4	22..	181..
	A A						479	6.4	34..	33..	207..
	A A						423	2.9	36..	26..	192..
20	A A						693	9.3		34..	110..
	A A						512	4.8	11.3	33.4	102..
	A A						374	10.5	12.4	20..	31..
21	A A						561	21.16	34.6	23.9	98.2
	P A M		94	20	96.3	100.3					
	P P M		112		95..	102..					
	P A M		100		78..	99..					
	P P M		104		79..	101..					
10	P A M		96	14	78..	98..					
	P P M		100		82..	101..					

DURATION OF HOSPITAL GANGRENE.

I have observed no uniform periods in the progress of this disease, to either a favorable or fatal termination.

As far as my observations extends, the duration of hospital gangrene depends upon the condition of the system and constitutional powers, at the time of the infection; the extent to which the constitution is involved by the absorption of the gangrenous matters; the position, relations, and functions of the diseased parts; the rapidity and extent to which the disease progresses before it is arrested, by the powers and processes of nature, or by treatment; the nature of the local and constitutional treatment; and above all, upon the hygienic condition of the hospital in which the patients are treated.

Bad diet, previous exposure and hardship, together with the atmosphere of crowded, filthy camps, beleaguered cities, and filthy crowded prisons, induce a state of the system which favors the origin and rapid spread of hospital gangrene. Such derangements of the blood and tissues and in the physical and vital forces as we find in scurvy, appear to be eminently adapted to the rapid spread of hospital gangrene.

The effects of bad diet, exposure to cold and wet, with imperfect clothing, and of the constant inhalation of deleterious gases arising from animal and vegetable decomposing matter, may gradually induce such a change in the composition of the living tissues, that they are prone to disintegration, and when any poisonous agent capable of exciting rapid change, as that which produces hospital gangrene, is introduced, the physical and chemical and vital powers are so reduced, that the disintegration excited is not only rapid but wide spread. We might call this an unstable condition of the chemical elements and physical and vital forces of the living system, and with some show of analogy compare it to that of certain unstable compounds as the iodide of nitrogen and chloride of nitrogen, which are rapidly altered even by mechanical motion.

It is manifest that when such a state of the system has been induced, the spread of gangrene will be far more rapid and extensive, and the convalescence will be more tedious than in healthy constitutions. And even under the best local treatment, the

recovery is *necessarily tedious* in constitutions broken down by the agencies just specified, and by habits of intemperance and vice.

Even when the constitution is vigorous and healthy, before the infection, the absorption of the gangrenous matter and its products, may induce a state of general derangement and depression, similar to that just alluded to, as resulting from the causes which may be considered as extraneous and accidental. When the system has been once thoroughly poisoned by the matter of hospital gangrene, the recovery will be tedious if not exceedingly doubtful under the best local and constitutional treatment.

The natural temperament appears to exert an important effect upon the progress of hospital gangrene. All things being equal, the disease will be most readily managed and convalescence will be most rapid in the *nervo-sanguine* temperament. Men with black hair, and eyes, and dark sallow complexions of the bilious, *nervo-bilious*, and *bilio-lymphatic* temperaments, appear to suffer most in the acute stages, and to have the most tedious convalescence. One or all of these causes may tend to aggravate the disease, and prolong its course. Any system of treatment which neglects the previous condition of the system, or that induced by the absorption of the poison, and its products, should be condemned as radically defective. Thus in hospital gangrene, engrafted upon a scorbutic system, what folly would it be to treat the disease entirely by local remedies, without any attention to the derangements of the blood and of several of the important organs, and of the general nutrition of the body.

That the position, relations and functions of the diseased parts, have much to do with the character and duration of hospital gangrene, would seem to be almost self-evident. The disease is especially dangerous, when located upon, or in the vicinity of a large joint, or along the track of important blood-vessels, as upon the neck over the track of the jugular veins and carotid artery; or in the thigh over the femoral vein and artery; or in the neighborhood of important organs, as the testicles and lungs.

I have never seen a case of recovery from this disease, after the opening of the hip or knee-joints; and in fact in all cases where the elbow-joint was opened, in which amputation was not performed the result was fatal.

The exposure and consequent death, of bones denuded of flesh and periosteum by hospital gangrene, greatly prolong convalescence. A portion of dead bone, is one of the most common causes of prolonged and tedious and exhausting suppuration from wounds even after the removal of all gangrene, and the establishment of healthy florid granulations. The system may, after a prolonged struggle, finally sink under the irritation and extensive suppuration caused by a portion of dead bone, after the system has successfully resisted the most extensive and dangerous destruction of tissues by the gangrene. In such cases, nature perishes in the attempt to throw off the dead bone; or during the depressed and irritated state induced by the action of the poison, and by the inflammatory process, and the constitutional disturbances which it has excited, the stomach and bowels may give way, and the patient fall a victim to gastritis or diarrhoea.

The nature of the local and constitutional treatment, has much to do with the progress and extent and duration of hospital gangrene, for if the disease be due to the action of a certain kind of animal matter, if it be possible to destroy that matter by chemical agents, and at the same time arouse by the same means, the surrounding tissues, with healthy inflammation, it is evident that the physician possesses the means of cutting short the disease. After the arrest and removal of the local disease, the period of convalescence, will depend upon various circumstances, as the extent to which the general system has been involved, the extent of the local injury, and the condition of the wound, and the surrounding hygienic state.

But, above all, the duration of hospital gangrene, will depend upon the hygienic condition of the hospital, and the sanitary regulations. If the hospital be crowded with wounded and gangrene cases, if it be poorly ventilated, and if but little attention be paid to the cleanliness of the bedding and utensils, the patients will be liable to constant returns of the disease, introduced through one or all the avenues of infection existing in filthy badly regulated hospitals. In such cases, patients may be cured of the gangrene several times, and finally die of a recurrence of the disease. I have seen nurses dress healthy granulating wounds with the same filthy hands, sponges and instruments, which but a

moment before had been busy in cleaning and picking the most offensive gangrenous wounds. The tendency of the disease is to a low depressed state of the nervous system, and of the general and capillary circulations, and hence *bed-sores* are exceedingly common in this disease when the patients are not properly attended to; and there is no doubt but that in the hands of inattentive and slovenly surgeons, bed-sores are the cause of most tardy convalescence and even death itself in hospital gangrene. As far as my observations extend, bowel affections, and especially obstinate diarrhœa, are much more liable to attack patients with hospital gangrene in dirty foul crowded hospitals, than in those properly regulated.

DISABILITY RESULTING FROM HOSPITAL GANGRENE.

The extensive destruction of tissue, caused by this disease, will in many cases involve the permanent injury of the affected limbs.

The character and extent of the disability will depend upon the situation of the gangrene, as well as upon the extent of its ravages.

When the disease invades tissues in the region of large blood-vessels and nerves, impaired circulation, nutrition, and even complete paralysis of the parts below the seat of injury may result. Withered, discolored, cold, contracted and paralyzed arms and legs, are sometimes seen, even at this period of the war, as the results of the local injuries inflicted by hospital gangrene. Even when the important nerves and blood-vessels are not injured, the denuded muscles which had lost their natural fibrous coverings, and even in many cases their natural tendinous attachments, during the process of healing by granulation form numerous new attachments, and the symmetry and precision of the muscular movements are deranged.

When entire muscles, or only portions of one or more muscles are destroyed, more or less contraction, according to the position and actions of the muscles will take place.

In most cases, the extent of the disability, is in no manner related to the size or depth of the primary wound. A small scratch of the surface may be attended with as great destruction of muscular tissue, as the deepest wound. The extent and nature

of the contraction, whether forwards or backwards, or lateral, will manifestly depend upon the relations and actions of the muscles injured or destroyed.

During convalescence from hospital gangrene, it requires great resolution and attention on the part of the patient, as well as the physician, to overcome the contraction of the muscles. As far as my observation extends, many valuable soldiers are lost to the service, from inattention on the part of the nurses and medical attendants to the posture of the body, and of the affected limbs during the progress of hospital gangrene. Whilst endeavoring to place the diseased limbs in the most favorable position for a perfect cure, without unnecessary deformity and contraction, it should also be remembered that there is a marked tendency to the formation of the most distressing and dangerous bed sores in all parts subject to long continued pressure, on account of the depression of the general and capillary circulation, and of the nervous and muscular forces, and the derangement of nutrition induced by the atmosphere and action of the poison and its organic products. The physician has also to regard at the same time, with the most scrupulous care, the proper *drainage of the wound*.

I have instituted inquiries at various times, to determine, if possible, the number of soldiers lost to the Confederate service, on account of disability following hospital gangrene, but have thus far been unable to form any approximate estimate, on account of the following difficulties:

It is evident that the field reports, furnish no materials for such an inquiry, as the patients do not remain long enough in the regimental brigade and division hospitals, to determine the results of any injury, and after the patient is transferred to the general hospital, his subsequent history is, in most cases, lost to the field surgeon.

In the general hospitals, the cases are frequently transferred from one hospital to another, and in the present system of registration, his disease and injury, with even the date and character of his wound appears anew upon the records of every hospital which he enters, so that the cases recorded in the general hospitals connected with the Confederate armies, greatly outnumber those transferred from the field.

Again, hospital gangrene, under the title of phagedæna gangrenosa, has only recently been introduced into the list of diseases recorded in the Confederate reports of the sick and wounded; thus, the first report from the general hospitals attached to the army of Tennessee, in which this disease appears, was for the month of July, 1864.

The losses from disability occasioned by hospital gangrene have been considerable in the Confederate armies, up to the present time, and will most probably progressively increase as the war with its numerous privations, and rapidly accumulating horrors advances.

The service has lost far more men from the effects of the gangrene, destroying the power and use of limbs, than from the actual number of deaths caused by this disease.

CAUSES OF DEATH IN HOSPITAL GANGRENE.

When hospital gangrene progresses unfavorably, the constitutional symptoms, become progressively more grave, and the fatal termination is generally announced by a feeble, rapid pulse, extreme prostration, twitching of the tendons, vomiting, hiccough, involuntary dejections, and oftentimes coma. Many cases, however, die without any derangement of the brain, and the patients are sensible and calm, up to the moment of death.

Deaths from hospital gangrene may result from one or more causes, as :

1st. Progressive failure of the powers, under the action of the depressing and irritating effects of a large and constantly increasing wound; and of the derangement in the constitution of the blood, and of the nutrition induced by the absorption of the gangrenous matters and its products.

2d. Repeated hæmorrhage from the blood-vessels exposed and eroded by the gangrene.

The separation of the dead parts, is almost always accompanied with more or less hæmorrhage, and in the last stage of the disease, there is frequently a bloody oozing from the surface of the denuded parts.

When hæmorrhage takes place from the large arteries, which

require ligation, it happens that in the severest cases, the coats of the arteries are sometimes ruptured by the ligature, and when the hæmorrhage is controlled by pressure, the limbs becomes greatly swollen, and the progress of the gangrene accelerated. In such cases, whether the ligature, and the mechanical means of compression be applied or withheld, an unfavorable issue appears to be almost equally certain. The sesquichloride and persulphate of iron should always be used freely locally in such cases, in addition to the other measures.

When the forces have been reduced by the long continued action of the gangrenous poison, a very slight hæmorrhage will sometimes cause death.

3d. Entrance of air into veins eroded and opened by the ravages of hospital gangrene.

As far as my observations extend, death from this cause is of rare occurrence. We have already in the section relating to the changes of the blood, presented an interesting case illustrating this mode of death. By post mortem examinations, I have been able to determine the important fact, that the blood is frequently coagulated, or rather a firm fibrous laminated clot forms in veins surrounded by gangrenous matter. This formation of fibrous clots in the veins appear to precede the erosion of their walls. And hence, by this process and provision of Nature, we do not often have the entrance of air into the veins, when they are destroyed by hospital gangrene. We have before shown, that the fibrin of the blood is increased above the normal standard, and that even in the worst cases, the blood is capable of forming a firm clot.

4th. Opening of the large joints by the gangrene.

When gangrene attacks parts in the neighborhood of the hip and shoulder joints, or of the knee and elbow joints, the disease, all things being equal, as to its intensity and the condition of the system, is far more dangerous than when situated upon the middle parts of the thigh, leg, arm, and fore arm.

The opening of a large joint to the air subjects the patient to the additional irritation of the large diseased synovial membrane; and the surface for the action and absorption of the gangrene is

at once greatly increased. The gangrenous matters frequently accumulate within the opened joint, and still farther, by their putrefaction and absorption increase the danger. The membranes lining the articulating surfaces of the bones, are finally eroded by the gangrene, and the extremities of the bones themselves are attacked in their most vascular and spongy portions. When the extremity of a bone is thus opened, the gangrenous sanies may descend by gravity, or ascend by capillary action, through large tracts of sound bone; and in this way by the opening of a joint, the difficulties of any case may be greatly increased, and, in fact, rendered hopeless, unless the limb be promptly amputated.

5th. Formation of large bed-sores during the progress of the disease, and the appearance of gangrene in them.

The tendency of the poison of hospital gangrene, after its absorption, is to the rapid derangement of the constitution of the blood, and of the nutrition of the body generally; and by its action, the general and capillary circulation are greatly depressed and deranged. It follows from this that all parts subjected to continuous pressure in this disease are liable to death. Hence, the most scrupulous attention should be paid to the change of posture, and to the friction and stimulation of all parts necessarily subjected to pressure in patients suffering with this disease. I have seen a number of cases, which appeared to terminate fatally, entirely on account of the gangrenous bed-sores, after all gangrene had been removed from the original wound, in which both granulation and suppuration had been established.

6th. Diarrhœa resulting from the irritant action of the poison of hospital gangrene, upon the intestinal mucous membrane.

After the absorption of the gangrenous matter, the immediate cause of death, is, in many cases, of long standing, profuse and uncontrollable diarrhœa. In the early stages of the disease, the bowels are most generally constipated, and the use of occasional purgatives beneficial; but when the disease has continued for a length of time, and a large surface has been exposed to the action and absorption of the deleterious materials, diarrhœa of an obstinate fetid character frequently sets in, and finally carries off the patient.

7th. Extensive and rapid disorganization of the tissues, around the

original wound, beneath the sound skin, accompanied by absorption of the gangrenous matters, great nervous and muscular prostration and obstinate diarrhœa.

8th. Mortification of internal organs, induced by gangrenous matter absorbed from the local disease.

The absorbed gangrenous matter, may, in certain cases, excite mortification of important internal organs. The development of gangrene within important internal organs may take place rapidly, and sometimes without the manifestation of such symptoms during the life of the patient as would indicate the true nature of the disease.

It is probable that in many of these cases, the organ which becomes gangrenous, was previously in a diseased state, either of active inflammation or of progressive derangement.

If the poison of hospital gangrene is capable of transmission through the atmosphere, to inflamed surfaces, cases of pneumonia should never be treated in the same ward, or in close proximity with this disease.

9th. The invasion of organs essential to life, by the direct destruction of intervening structures.

When gangrene attacks the stump after amputation, at or near the shoulder-joint, the disease may progress along the cellular tissue into the cavity of the thorax, and invade the pulmonary structures, and thus produce a rapid fatal termination. I have seen the lungs thus attacked in a case of resection of the humerus near the shoulder-joint. I have observed that in those cases in which hospital gangrene attacked the lungs, the complexion immediately assumed a moist, cadaverous, sallow hue. When gangrene attacks the tissues in the groin, it may penetrate the abdomen, and speedily cause death. In like manner when the scrotum and testicles are attacked by the disease, it may penetrate the abdomen. During the present war, I have seen three cases of gangrene of the scrotum and testicles, in which these organs were entirely exposed, and even destroyed. Each case terminated fatally.

10th. Pyæmia.

It sometimes happens that after the gangrene has disappeared

from the wound, and after the appearance of granulation, and the formation of pus, this fatal disease supervenes. It is a subject for interesting investigation, to be settled only by carefully recorded cases, whether pyæmia is more common in cases of hospital gangrene, than in those cases in which the wounds present the appearance of sthenic inflammation. It is reasonable to suppose, that all depressing causes, which tend to produce such a state of the system as favors the rapid disorganization of the structures would favor the production of pyæmia.

In several cases of this disease supervening upon hospital gangrene which have come under my observation, the symptoms have been marked and distinct from the first disease, the urine has assumed a brilliant carmine tint, and after death, the veins of the diseased parts were discovered, upon dissection, to be distended with pus.

11th. *Phlebitis.*

12th. *Various results or sequela of the local and constitutional effects of hospital gangrene, as profuse and unhealthy suppuration from large granulating surfaces—necrosed bones; causing irritation and keeping up suppuration, and hectic fever—permanent impairment and debility of the digestive organs.*

II.—CAUSES OF HOSPITAL GANGRENE.

1st. *A debilitated and cachectic state of the constitution. Such derangement of the solids and fluids as favors the production of hospital gangrene, may be the result of exposure, fatigue, bad diet and impure water; and also of the rapid or slow action of a special poison in a low, humid and miasmatic atmosphere.*

If the doctrine advanced by John Hunter, that a certain degree of vital tone or energy is requisite for the formation of coagulable lymph, by which the spreading of inflammation and sphacelation will be prevented, and that when owing to deficiency of vital energy, vascular action is incompetent to the formation of coagulable lymph, these lesions will extend, and the morbid fluids will contaminate the surrounding tissues, be accepted as an axiom in pathology, and be enlarged so as to embrace the doctrine that the character and progress of inflammations will depend also upon the physical and chemical constitution of the solids and

fluids, we will have an explanation of the fact, that hospital gangrene, which was almost unknown as an American disease, previous to the present war, has, at least, in the Confederate armies, progressively increased in amount and severity.

An insufficient supply of food, as well as the prolonged and too exclusive use of salt food, not only impair the efficiency of soldiers by rendering them less capable of enduring exposure and fatigue, and by inducing that cachectic state of the system which is favorable to the development of diarrhoea and scurvy; but also render the accidents of battle more fatal by the unfavorable progress of inflammation in gunshot wounds.

In the earlier periods of the present war, the Confederate armies were composed in large measure of men who had been accustomed to an abundant and varied diet, a large portion of which consisted of animal food. Notwithstanding the unavoidable crowding of the hospitals, and the existence of all the circumstances most favorable to the development and spread of hospital gangrene, in the first months of the war this disease appears to have been almost unknown, until a change had been wrought in the constitution of the soldiers, by fatigue, exposure, and reduced rations, from which both coffee and vegetables were almost universally absent.

A low, moist stagnant, malarious atmosphere, is not only in itself favorable to the origin and spread of hospital gangrene, but it also produces in troops serving in low malarial regions, changes in the solids and fluids unfavorable to sthenic inflammation.

Thus, as I have shown by previous investigations, the malarial poison produces profound alterations in the constitution of the blood. Under its action, the colored blood-corpuscles are more rapidly, and to a greater extent, destroyed than in any other disease, with the exception perhaps of pyæmia. The fibrin is diminished, and also altered in quality.

The albumen is, in like manner, diminished. The extractive and coloring matters of the blood are frequently increased. During the active stages of malarial fever, phosphorus and the compounds of phosphorus in the nervous structures and in the colored blood corpuscles, as well as sulphur and the compounds

of sulphur, in the muscular structures, undergo more rapid changes than in the normal state,—and phosphoric acid and the phosphates, and sulphuric acid, and the sulphates appear in increased quantities in the urine. The waste of phosphorus and its compounds in the blood-corpuscles and nervous structures during the active stages of the fever, are far greater than the supply of these elements through the blood. During the slow action of the malarial poison, as well as during the active stages of the paroxysm, important changes take place in the liver and spleen. In both organs, the colored blood-corpuscles are destroyed in large numbers, and the coloring matter resulting from the disintegration of the red corpuscles accumulates in them, and in conjunction with other changes in the nutritive process of these organs produce the alterations characteristic of malarial fever. That the chemistry of the body is still farther deranged in malarial fever, is evidenced by the changes of the excretions. Thus, during the chill, and at the very commencement of the hot stage, phosphoric acid disappears almost entirely from the urine; as the hot stage progresses, and the febrile action and heat commence to decline, there is an augmentation of phosphoric acid. But what is still more important in its bearings upon inflammatory affections engrafted upon the malarial constitution, the uric acid is either increased, or remains at the normal standard, during the chill; disappears almost entirely during the fever, and then increases rapidly and rises to a high figure at the subsidence of the febrile excitement, and often continues for days, two and three and even six times more abundant than in the normal state. If it be true that the presence of a morbid agent in the blood, as uric acid, in gout and rheumatism, will often prove an excitant to inflammatory action, then this tendency in malarial fever, to the generation of large quantities of uric acid, during the intermission, and even during the period of convalescence, is important in its bearing upon inflammations accompanying or following malarial fever.

It results from these effects of the malarial poison.

First. When inflammation is excited from any cause, in a system subjected to the influence of the malarial poison, the natural tendency is for the inflammation to assume a low form, from the altered condition of the constituents of the blood and

structures, and from the derangement in the process of nutrition, and of those physical and chemical acts by which the nervous and muscular forces are developed. It is well known that the causes which are most influential in the production of inflammation, are such as enfeeble the heart, impair the tone of the arteries, reduce the activity of the secreting organs, and debilitate the muscular and nervous forces. Imperfect nourishment also, either in consequence of the defect in the quantity or quality of the food, or of incapacity of the digestive powers, impairs the power of the system to resist the effects of deleterious and depressing agents, as cold, and produces a liability to low forms of inflammation and fever, and to various epidemic and contagious diseases.

In malarial fever, even when the digestion is unimpaired, the action of the poison, by impairing the constitution of the blood, and by deranging the nutritive processes of the different organs and tissues, and by deranging and depressing the chemical actions concerned in the development of the physical and nervous forces, produces similar results to those witnessed in ill fed and ill-conditioned beings.

The process of inflammation, whilst including both congestion and determination of blood, is essentially more complex than either or both of these conditions, and includes changes of the blood within the vessels, and changes of the relations of the capillaries to the blood, and of the blood to the surrounding tissues. The character of these changes as well as the extent and progress of the inflammation, will depend upon the constitution of the blood, the forces moving the blood, and the condition of the forces active in the nutrition of all the organs as well as of the forces especially active in the inflamed tissue. Thus when the character of the blood has been altered, and the forces depressed, the solid products of inflammation are less capable of organization, the lymph effused possesses inferior plasticity, and the effects of the local inflammation upon the general system in causing inflammatory fever, are more depressing and dangerous. As therefore the tendency of the malarial poison is to derange the conditions upon which the maintenance of healthy nutrition depends, viz., the regular supply of healthy blood possessing a

definite composition and fixed relations of its elements, and of a certain supply of physical and nervous force, and the healthy constitution of the organs and tissues, it is evident, not only that inflammation engrafted upon the system laboring under the effects, or under the direct action of the poison, must be correspondingly altered from its progress in the healthy constitution ; but also that the state of the system induced by the action of the malarial poison is conducive to the origin of inflammation.

Second. From the destruction of the fibrin, and red corpuscles, consequent upon the action of the malarial poison, the tendency of inflammation excited in systems under the influence of the malarial poison, is to diffusion. The increase of fibrin in the blood and in the inflamed structures appears to be destined in the economy of Nature to limit and circumscribe the inflammatory action by the fibrous matter thrown out within and around the inflamed part. The colored blood-corpuscles which crowd the inflamed parts appear to contribute by the chemical changes which they excite, and especially by the increased oxidization of the albuminoid elements, to the formation of fibrin, which in this view may be considered as one of the controlling and limiting elements of inflammation. Whatever, therefore, tends to diminish the red corpuscles and fibrin, tends to interfere with the natural processes employed by Nature in the limitation of inflammation, and directly promotes the diffusion of the inflammation over a greater extent of tissue, and in a corresponding degree renders it more severe and dangerous.

From these facts and considerations, we conclude that, whilst the malarial poison cannot be said directly to produce hospital gangrene, still it is capable of inducing such changes in the blood and in the nutritive and excretory processes as alter the usual course of inflammations.

In scorbutic patients, all injuries tend to form ulcers of an unhealthy character, and even so simple an operation as vaccination may be followed by the most extensive sloughing and even gangrene of a fatal nature.

In dejected scorbutic prisoners confined in filthy military prisons, I have seen the smallest accidental injuries and abrasions of the surface, as from splinters, or bites of insects, followed by

such extensive gangrene as to necessitate amputation. The scorbutic condition induced by salt meat and farinaceous food without fresh vegetables, frequently modifies the course of diseases, poisons wounds however slight, and lies at the foundation of those obstinate and exhausting diarrhoeas and dysentery, which prove so fatal to beleagured armies, to soldiers in military prisons, and to seamen upon long voyages.

Scurvy and hospital gangrene frequently exist in the same individual. In such cases, vegetable diet, with vegetable acids, would remove the scorbutic condition without curing the hospital gangrene.

It has been well established by my own observations, as well as those of Blane, Trotter and others, that the scorbutic condition of the system, especially in crowded camps, ships, hospitals and beleagured cities, is most favorable to the origin and spread of foul ulcers and hospital gangrene. In many cases, it is difficult to decide at first whether the ulcer be a simple result of the scorbutic state, or of the action of the poison of hospital gangrene; for there is great similarity in the appearance of scorbutic ulcers and genuine hospital gangrene. So commonly have these two diseases been combined, that the description of scorbutic ulcers by many authorities, evidently, includes also many of the prominent characteristics of hospital gangrene, as will be seen by a reference to the description of Lind, Trotter, Blane and others.

2d. The air of crowded hospitals, tents, and ships, loaded with animal exhalations.

The causes examined in the preceding section, should more correctly be termed, conditions favorable to the development of hospital gangrene. The most essential condition and efficient cause of hospital gangrene, is found in the exhalations which contaminate the atmosphere of the crowded, badly ventilated and filthy tent, prison, hospital or ship.

In the present condition of the Confederate troops, exposed as they have been to unparalleled labors and fatigue, with short and unvaried rations, the crowding of the wounded into close box cars, and thence oftentimes into hastily extemporised, badly ventilated and filthy houses and hotels for hospitals, is almost uniformly attended by the appearance of hospital gangrene. The

severity of the disease will be greatly increased in a damp, warm, low, malarious atmosphere. In a stagnant moist atmosphere, it is almost impossible to secure in the wards of large hospitals, even when the windows are kept always open, such a constant change of air, as will prevent the deleterious action of the exhalations from the wounded surfaces, and from the lungs and skin and excretions of the patients. As far as my observations extend, I am led to the belief that the exhalations act not only upon the wounded surface, but also through the lungs and skin; and that by the continuous absorption of these deleterious matters through these channels, the nervous system may be so depressed and the constitution of the blood so altered, that hospital gangrene may arise independently of local action. This question however admits of much investigation and discussion.

It is now at least believed by a large portion of the profession, if not established, beyond all doubt, that the animal exhalations of crowded tents and hospitals, are capable of developing in the healthy nurses, two distinct species of fever, characterized by many of the symptoms of hospital gangrene. It is without doubt true, that the heavy mortality from pneumonia and typhoid fever, in the Confederate hospitals, has been due in great measure to the depressing effects of animal exhalations; and it is probable that many cases of pneumonia have been converted by these agents, into cases of hospital gangrene of the lungs.

3d. The contact of the gangrenous matter, with diseased and wounded surfaces, as in using unclean sponges, bandages, wash, bowls and surgical instruments.*

No doubt appears to exist in the minds of many surgeons, that hospital gangrene may be readily communicated by actual contact of the matter, from one wound to another, and that the matter may be inoculated into the healthy subject, just as in the case of the matter of small-pox, and produce a poisoned wound exactly similar to the one from which the matter was taken.

I have demonstrated conclusively by experiments upon animals, and by careful observation of gangrene in healthy wounds and in nurses attending gangrenous patients and upon the origin of the disease in washerwomen, who did not enter the wards or come in contact with the patients, but who simply washed the clothing

and rags soiled with the discharges of gangrenous wounds, that the matter of this disease possesses contagious properties, and that it will reproduce itself when inoculated upon a healthy individual.

After careful observation and consideration, the following conclusions have been drawn :

First. Hospital gangrene is caused by the action of an irritant corrosive organic poison, generated during the decomposition of animal matter under certain conditions, and capable of exciting change and decomposition in living structures with which it is brought into contact, after the manner of a ferment.

Second. Hospital gangrene may at any time arise *de novo*, when sick and wounded soldiers are crowded together in badly ventilated houses, filthy hospitals, close box cars, or on ship board.

Third. Hospital gangrene will arise most readily under these circumstances, when the soldiers have been on scanty and poor food, and have been exposed to fatigue, loss of rest, the constant excitements of battle, and the unhealthy atmosphere of crowded filthy camps and beleaguered cities.

Fourth. When crowded together a large proportion of the wounds may become gangrenous, without any direct application of the matter, and before even the dressings have been removed.

Fifth. If cases of hospital gangrene be introduced amongst the sick and wounded of any hospital in which the disease is not prevailing, the rapidity with which it will spread will depend upon the hygienic condition of the hospital, and also upon the elevation of its situation, and the temperature and moisture of the climate.

Sixth. If the preceding propositions be true, it is evident that the crowding of human beings together, whether sick or well, in confined spaces, so deteriorates and poisons the atmosphere, that all wounded surfaces are liable to become infected. As the disease, sometimes arises amongst freshly wounded soldiers, without any introduction of the disease, from without, and also amongst isolated cases of wounds introduced into hospitals crowded simply with the sick ; the conclusion is inevitable that the disease arises as much from the action of air rendered foul by animal exhalations, and by changes in its chemical, physical and electrical constitution, upon wounded surfaces, as from any contagious effluvia arising from the gangrenous wounds.

III.—TREATMENT OF HOSPITAL GANGRENE.

Measures for the prevention of the disease.

The observations upon the relations of insufficient food, fatigue and the exhalations of crowded tents and hospitals to the origin and spread of hospital gangrene, indicate at once, without farther discussion, the best means for the prevention of this disease.

Abundant supplies of nutritious animal and vegetable food, free ventilation with the largest possible supply of fresh air to each patient, with scrupulous cleanliness of the wounds, as well as of the person's clothing, bedding and apartments of the wounded are the great prophylactic measures against hospital gangrene. When this disease appears in a filthy or crowded hospital, a heavy responsibility rests upon the medical officers. It would be far better after great battles to scatter the wounded under sheds, and even under trees, than to crowd them into close tents and hospitals, or to transport them to a distance in close box cars. Unfortunately it has been deemed necessary after several great battles, to transport large numbers of wounded soldiers in close, badly ventilated box cars, hundreds of miles from the scene of action. In many instances, the supply of water was limited, the wounded men shut up in these hot confined boxes suffered from thirst, and the unwashed and filthy wounds emitted a foul stench which contaminated the entire atmosphere. The severest epidemics of hospital gangrene have appeared in wounded subjected to these most favorable conditions for the origin and spread of the disease.

In general hospitals, each seriously wounded man, should be allowed if possible, two thousand cubic feet of air; the severest cases should be distributed uniformly amongst the slightest cases; and each ward should be thoroughly cleansed, white-washed and fumigated, at least every two months. The free use of Labarraques' solution of hypo-chloride of soda, as a wash to all serious wounds, will not only add to the comfort of the patients, and promote the healing of the wounds, but it will also tend to prevent the origin and spread of hospital gangrene. When Labarraques' solution cannot be obtained, a weak solution of nitro-

muric acid, in the proportion of one fluid ounce of the acid to a gallon of water, will make a useful disinfecting and slightly stimulating wash for wounded surfaces. This solution should be prepared fresh each morning, and the wounds should be carefully washed with it, at least morning and evening.

It is well established that fumigations with chlorine, are more efficacious in purifying the wards of hospitals than any other means. In the present state of the Confederacy, however, it is almost impossible to command the necessary supplies of the mineral acids, and the best indigenous substitute which has fallen under my observation is the tar fumigation. In the tar smoke, carbon in a highly divided state, together with various disinfecting emperumatic matters, are the active agents which purify the infected atmosphere of the crowded hospital. This smoke so far from irritating the lungs, appears to act beneficially upon pulmonary complaints.*

CONSTITUTIONAL TREATMENT OF HOSPITAL GANGRENE.

Inflammation in the healthy system is a reparative process of Nature, and should be studied and treated as a modification of the natural processes concerned in the preservation of the body; or, in the language of John Hunter: "Inflammation in itself is not to be considered as a disease, but as a salutary operation, consequent either to some violence or some disease;" it is "only a disturbed state of parts which require a new but salutary mode of action to restore them to that state wherein a natural mode of action alone is necessary."

When a foreign body is thrust into the living tissues, the delicate capillaries are broken up, the mutual relations of the forces are disturbed, the nerves are injured so as no longer to be capable of exerting their normal influence. If the foreign body be im-

NOTE.—* Just after the close of the recent war, I commenced the use of carbolic acid as a stimulative and disinfecting application to wounds and unhealthy ulcers, and the results have been most satisfactory.

A solution of one ounce of the crystallized acid to the gallon of water, would make a most useful and cleansing wash to all unhealthy wounds and ulcers, and when partly purged, in the proportion of from mx xv to one drachm to the ounce of simple aërate, it acts most beneficially upon wounded surfaces, and is not washed entirely away when the blood is seced.

mediately withdrawn, and if the animal wounded be in a state of perfect health, that is, with a proper constitution of the blood and structures, and a proper circulation of the forces, the blood, and especially the coagulable lymph, may close up the wound, and, with the exception of pain, and of a temporary congestion of the surrounding parts, from the obstruction of the circulation in the injured capillaries, thus forcing more blood around the injured part, as well as from the disturbance of the nervous force and of the process of nutrition in the surrounding capillaries, no other phenomena are manifested. The effused fibrous matter, endowed itself with life and surrounded by living tissue, and subjected to the influences of living tissue, passes through various changes which resemble the changes in normal nutrition, secretion and development, and which result in development of cells and fibres, and in the repair of the injured part.

If, on the other hand, the structures are too much injured to be repaired in this manner, the same disturbances and the same phenomena are manifest; but, being increased in intensity, the changes in the nutrition of the injured part progresses to correspondingly greater effects. The same effusion, and the same reparative processes are active in the one case as in the other, but in the latter, the dead tissue acts as a foreign body, and must be removed, and a process instituted by which its place may be supplied by other living matter. As the matter effused and the injured tissue possess a definite chemical constitution, and are related by definite affinities to the surrounding forms of matter, and as they are subject to the action of fixed forces exciting and controlling the nutrition and circulation of the surrounding parts, the products will, to a great extent, be uniform in the healthy organism.

When, on the other hand, a mechanical injury is inflicted upon a living animal whose forces are depressed, and the nutritive elements of which are deficient in quantity, the process of repair will be correspondingly retarded, and the products will be correspondingly altered from those formed in the healthy organism. If the system be under the influence of some disturbing agent, as a poison, at the time of the reception of the injury, the characters of the inflammatory process will manifestly depend upon the affini-

ties of the extraneous substance or poison for the elements of nutrition, and upon its power to disturb the nutrition, secretion, excretion, and the nervous and muscular forces. In the case of a poison acting in the blood, its local and inflammatory effects will be chiefly manifested in that organ for which it has the greatest affinity, or in the nutritive processes in which it produced the greatest disturbance; and as the most essential changes of the blood take place in the capillaries, it is in these parts that we must look for the chief disturbances. In this case the effects of inflammation may be widely extended, not only by the reflexion of the local disturbances to other parts, through the nervous system, but also by the entrance into the circulation of certain products of inflammation which will be capable of inducing changes in the mass of the blood, and in the nutrition and secretion of various organs.

In this last form of inflammation, when, in addition to the local injury, we have a poisoned condition of the blood, and of the structures involved in the local inflammation, the manifest indications from the principles just laid down are :

First.—To remove the patient from all causes which tend to depress the system, and especially from those causes which are known to have been directly and specially active.

Second.—To eliminate the deleterious agent.

Third.—To restore the system to such a condition that healthy nutrition, reparation and inflammation may take place.

Fourth.—To induce such changes in the injured parts themselves, as will lead to a complete separation between the diseased and dead structures.

Fifth.—To destroy all poisonous matter in the diseased parts.

Sixth.—After the removal of the dead parts, and after the destruction of all contagious elements capable of disseminating the disease to the surrounding tissues, to stimulate the capillaries and absorbents around the local injury to healthy active inflammatory actions, as will result in the development of healthy granulations. The three last indications will be considered under the head of the *local treatment*.

In the treatment of hospital gangrene the first essential measure, without which the most enlightened system of treatment is

comparatively valueless and at best tardy, is to remove the patient from the crowded wards, and to secure for him in an isolated room or tent, the largest possible supply of fresh air.

We have seen that the constitutional symptoms in most cases of hospital gangrene, hold a prominent place. The dejected spirits, the depressed state of the nervous system, the small accelerated pulse, the feeble, sluggish capillary circulation, and the depressed state of the temperature in the extremities, all point to the supporting, tonic and stimulant plan of treatment as the only rational system. The therapeutical indications are to furnish the elements of healthy blood, and of active nutrition, secretion and repair—to excite and support vital power, and to allay nervous irritability. These intentions are best fulfilled by resorting to combinations of tonics and anodynes, after the morbid secretions of the bowels have been evacuated by gentle purgatives or enema. In many cases emetics may be used with benefit; and it will almost always be found best to evacuate the constipated bowels by a purgative, and to keep them gently open by salines. The subsequent tonic and supporting plan of treatment will prove far more certain and beneficial in its action after the bowels have been cleared of morbid secretions.

Blood-letting should be avoided as tending to a still farther depression of the enfeebled forces, and also as inflicting a wound which may become gangrenous. For similar reasons blisters should as a general rule be avoided.

Quinine and the tincture of the sesqui-chloride of iron, deservedly hold a high place in the estimation of Confederate surgeons in the treatment of hospital gangrene. In cases of ordinary severity three grains of quinine and fifteen drops of the muriated tincture of iron, administered three or four times during the twenty-four hours, will be found to be sufficient, in conjunction with the other measures, to induce a marked and rapid improvement in those patients who are properly isolated and ventilated. When the ravages of the disease are extensive, and the danger of hemorrhage great, the amount of the tincture of the sesquichloride of iron may, with benefit, be increased to twenty drops every two or three hours. I have derived benefit from the following formula: R sulphate of quinia ʒij, chlorate of potassa ʒij, tinc-

ture sesquichloride of iron $\mathfrak{f}\mathfrak{ss}$ j, hydrochloric acid $\mathfrak{f}\mathfrak{ss}$ j, distilled water $\mathfrak{f}\mathfrak{ss}$ j; mix the hydrochloric acid and distilled water, and dissolve in this acid solution the quinine and chlorate of potassa, and then mingle with the tincture of the sesquichloride of iron. Dose from thirty to sixty drops in a wineglassful of water (sucked through a quill to avoid injury to the teeth) every three, four, or six hours.

As far as my experience extends *quinine*, in large doses, exerts no beneficial effects upon the progress of the constitutional and local symptoms; the best results are accomplished with moderate doses.

Huxham's tincture of bark (*tinctura cinchonæ composita*) administered in full doses, varying from one fluid drachm to half a fluid ounce, every three or four hours, fulfils in this disease important indications as a stimulant, tonic, diuretic, and elegant stomachic cordial. This should be administered at the intervals between the doses of the chloride of iron.

The sesquichloride of iron may, with advantage to the patient, be administered in combination with chlorate of potassa, in the proportion of from ten to twenty drops of the former, and ten to twenty grains of the latter, dissolved in two or three ounces of water. This dose may be repeated every two, three, or four hours. Whilst we are unable to explain the exact manner in which chlorate of potassa acts upon the system, still it is well established that it proves highly beneficial in those complaints in which a depressed state of the solids and fluids shows itself by malignant typhoid symptoms, and a disposition to phagedenic ulceration and gangrene. The combination of this salt with sesquichloride of iron is especially valuable from the liberation of chlorine and hypochlorous acid.

Hydrochloric and nitric acids, singly or combined, exert beneficial effects in some cases. Whenever they are indicated the sesquichloride of iron, or the combination of this salt with the chlorate of potassa, will answer an equal, if not better purpose, except when there is marked torpidity of the liver. In such cases the nitro-muriatic acid should be employed internally, and in the form of the bath.

The arsenical solution (Fowler's solution arsenite of potassa) has been employed with benefit in some cases.

Oil of turpentine, camphor, musk, and warm aromatics and spices frequently prove beneficial, and may be administered in various forms of combination.

The stimulant and depurant effects of the oil of turpentine appear to be of some value in the treatment of hospital gangrene. To obtain decided effects upon the capillary circulation, in the debilitated state of the system in this disease, the oil of turpentine should be administered in full doses at short intervals of time. So slow is the system to respond to stimuli in hospital gangrene, that I have known this remedy to be given in teaspoonful doses, at regular and frequent intervals, without any marked effects upon the kidneys or bladder. It is, however, a question, whether these large doses, especially if they be continued for any great length of time, may not lay the foundation of disease of the kidneys and bladder. Opiates are indispensable in the treatment of almost any case of hospital gangrene, and should be administered, when necessary, freely, to allay irritability and to produce sleep, and to check excessive discharges from the bowels.

The *diet*, throughout the whole course of this disease, should be as highly nutritious as possible, and should consist chiefly of concentrated animal soups, soft boiled eggs, egg-nog, milk punch, etc., with a liberal supply of vegetables and ripe fruits, if they can possibly be obtained. Good brandy, whisky, wine, or porter, administered in moderate quantities, at short intervals, will prove highly beneficial in almost all cases.

LOCAL TREATMENT OF HOSPITAL GANGRENE.

Whether we regard the local affection as a poisoned wound, in which contagious, poisoned matters are continually generated, and from which the surrounding living tissues are contaminated, or look upon the destruction of the tissues as the result of deficient and perverted inflammatory action, the principles of the local treatment would, in either view, be much the same. If the first view be held, our efforts should be directed to the alteration, destruction, and complete removal of the dead and poisonous matters and tissues.

If the second view be accepted, the manifest duty of the physician would be to use such measures as will increase the vital power of the tissues and vessels, and enable them to form coagulable lymph, by which the disorganization may be circumscribed and arrested.

These indications are best fulfilled, by the liberal and thorough application of *concentrated fuming nitric acid*, to the gangrenous parts. In this application it is desirable that the nitric acid should not merely coagulate and alter completely the gangrenous matters, but should also come in contact with the sound parts, and by its action upon the fluids and surface of the exposed parts, stimulate the living structures into a new form of inflammatory action, which will cause the complete separation of all the dead parts, the arrest of the farther progress of the disease, by the more exalted condition of the sound parts, and by the effusion of healthy coagulable lymph, and the establishment of the process of repair. As the operation of dissecting away all the gangrenous masses and the subsequent application of nitric acid, is attended in many cases, with great suffering, it is advisable whenever practicable, to first put the patient well under the influence of chloroform and sulphuric ether. By performing this operation leisurely and thoroughly at first, much subsequent suffering is avoided. And from careful observation, I am persuaded that the disease was in many cases greatly protracted by the superficial manner in which the wounds were cleansed and the nitric acid applied.

In most cases, especially when the patients have been properly isolated, one thorough application of nitric acid will be sufficient if followed by the necessary constitutional and local treatment. If however the patients be retained in the crowded wards or tents, the most energetic treatment will fail entirely of arresting the disease.

After the entire surface of the wound has been thoroughly mopped with nitric acid, the subsequent treatment will consist in :

The careful removal of all dead masses and particles of tissue ; the thorough cleansing of the wound with water, and with solutions of chlorinated soda, nitro-muriatic acid, acetic and pyrolig-

neous acid, tar water, solutions of creosote, and Huxham's tincture of bark, at stated intervals during the day; covering the parts with flaxseed, meal, yeast, hop, or charcoal poultices, rendered stimulating with turpentine, spirits of camphor, tincture of iodine, camphorated tincture of opium, Huxham's tincture of bark, pyroligneous acid or creosote.

The prompt removal of all detached masses of tissue, and the thorough washing away of all morbid secretions, are most important means to prevent the recurrence of the disease, and to secure the establishment of healthy inflammatory action. Whenever a circumscribed portion of the wound looks unhealthy and gangrenous, the nitric acid should be applied directly to the diseased parts, care being taken that the *sound parts*, be not unnecessarily subjected to its action.

In many cases, before the wound assumes a healthy condition, instead of applying poultices, it is preferable to fill the cavity of the wound with lint or cotton, saturated with various stimulating fluids, as a weak tincture of iodine, oil of turpentine, tincture of camphor, tincture of Peruvian bark, or pyroligneous acid. When there is danger of hæmorrhage, either from large vessels, or from the general surface of the wounds, lint saturated with the undiluted tincture sesqui-chloride of iron, or with a strong solution of the per-sulphate of iron should be applied. It may be laid down as rule, that ligation, or amputation, should not be resorted to in cases of hæmorrhage in hospital gangrene, until these efficient styptics have been freely and fully applied to the bleeding surfaces.

Whilst the patient is retained in the effeted atmosphere, or whilst the disease is progressing, amputation will in most cases, prove worse than useless. Under such conditions hospital gangrene will invariably reappear in the stump, and the only effect of amputation will be to expose a larger diseased surface, and to bring the gangrene nearer the central organs. As a rule, no amputations, no matter what be the condition of the wounds, whether gangrenous or healthy, should be performed in the wards of a hospital in which gangrene is prevailing. Such practise is as reprehensible as the careless distribution of healthy and fresh wounds amongst the gangrenous wards.

When amputation is unavoidable, as in the case of the opening of large joints, or the destruction of important arteries and nerves, the patients, whether the wounds be gangrenous or not, if the disease be present in the hospital, should be isolated as far as possible, and every attention paid to proper ventilation, cleanliness and diet.

After the appearance of healthy granulation and of laudable pus, the stimulating, astringent, and caustic applications should be abandoned, or only occasionally used with caution, and the wound should be treated as any other simple granulating ulcer.

Various other applications have been recommended and employed by Confederate surgeons in the local treatment of hospital gangrene, as the actual cautery, sulphate of copper, acid nitrate of mercury, chloride of zinc, nitrate of silver, and persulphate of iron. These remedies, without doubt, exert beneficial effects, as I have myself frequently witnessed. The method, however, which has just been given, as far as my observation extends, is the most efficient.

